AD-A061 921 FEDERAL AVIATION ADMINISTRATION WASHINGTON D C SYSTE--ETC F/G 1/2

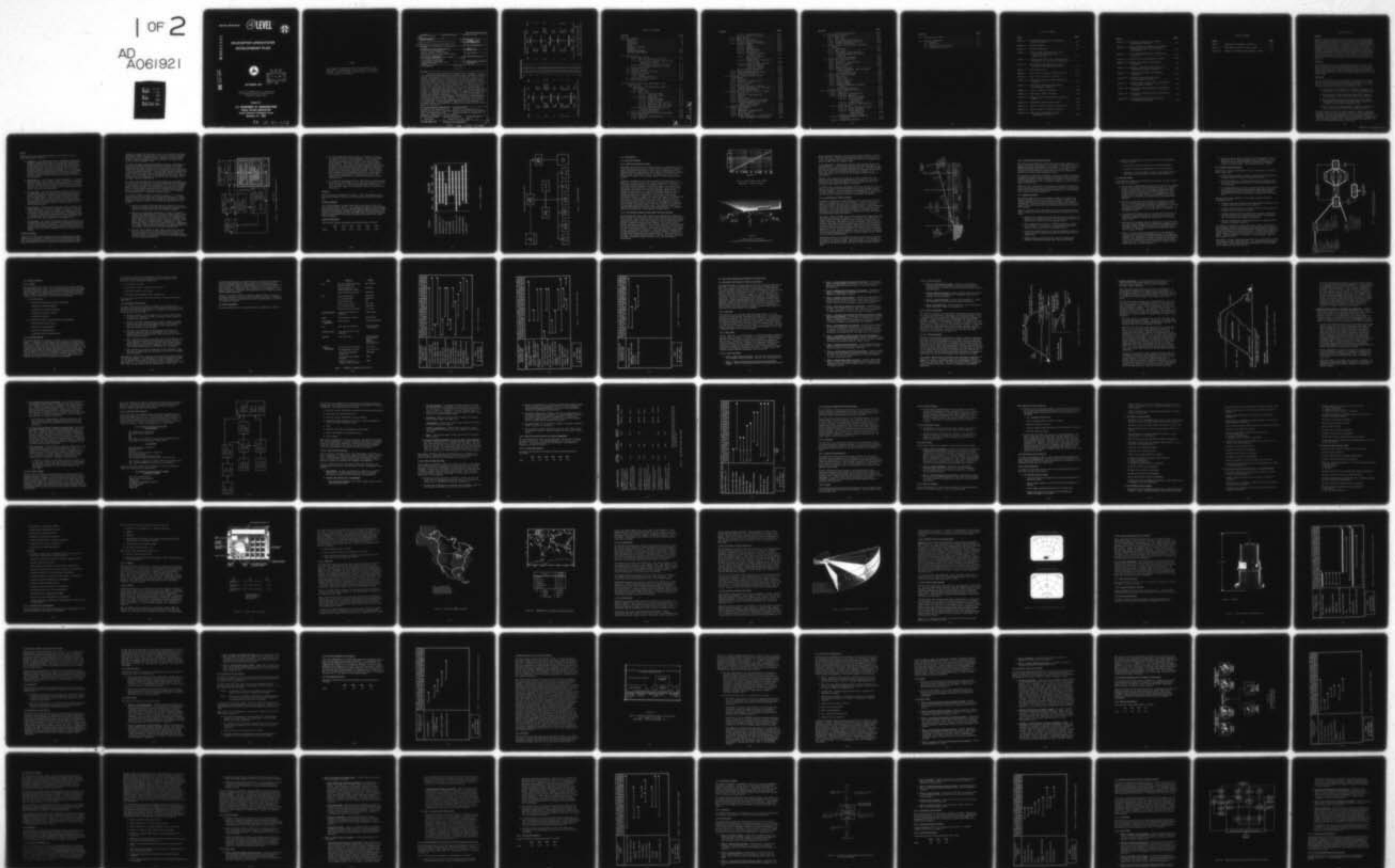
HELICOPTER OPERATIONS DEVELOPMENT PLAN.(U)

SEP 78

UNCLASSIFIED FAA-RD-78-101 NL

1 OF 2

AD A061921



1.0 1.1 1.25 1.4 1.6 1.8 2.0 2.2 2.5 2.8 3.2 3.6 4.0 4.5 5.0 5.6

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

Report No. FAA-RD-78-101

(12) LEVEL II

5C

HELICOPTER OPERATIONS DEVELOPMENT PLAN

SEPTEMBER 1978

Document is available to the U.S. public through the National Technical Information Service, Springfield, Virginia 22161.

Prepared for

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION
Systems Research & Development Service
Washington, D.C. 20590

NOTICE

Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
(14) FAA-RD-78-101		

4. Title and Subtitle	5. Report Date
(6) Helicopter Operations Development Plan,	(11) September, 1978
	6. Performing Organization Code
7. Author(s)	8. Performing Organization Report No.
Helicopter Program Staff ARD-706	PAR-517-78
9. Performing Organization Name and Address	10. Work Unit No. (TRAIS)
Federal Aviation Administration Systems Research and Development Service Helicopter Program Staff Trans Point, Washington, D. C. 20590	11. Contract or Grant No.
	13. Type of Report and Period Covered
12. Sponsoring Agency Name and Address	(9) Program Plan rept.
U.S. Department of Transportation Federal Aviation Administration Systems Research and Development Service Washington, D.C. 20590 (12) 116p.	14. Sponsoring Agency Code ARD-700

15. Supplementary Notes

16. Abstract

The Helicopter Operations Development Plan is designed to provide for upgrading and development of all those criteria, standards, procedures, systems, and regulatory activities which will allow safe, timely and economical integration of the helicopter into all-weather operations in the National Airspace System. It describes a five-year development program whose objective is to improve the National Airspace System so as to enable helicopters to employ their unique capabilities. It includes the collection of data (both near and long term) for use by the FAA and others to ensure full integration into the NAS of this rapidly growing segment of aviation. These areas are covered in the plan: (1) IFR Helicopter Operations; (2) Navigation Systems Development; (3) Communication Systems Development; (4) Helicopter Air-Traffic Control; (5) Weather Environment; (6) All-Weather Heliport Development; (7) IFR Helicopter Certification Standards; (8) Helicopter Icing Standards; (9) Helicopter Crashworthiness and (10) Helicopter Noise Characterization. The FAA groups, other Federal Government agencies and other organizations participating in this effort are identified. Program management responsibilities are addressed. A program schedule with milestones is presented and program funding requirements are identified.

17. Key Words	18. Distribution Statement
Helicopter, All-Weather Operations, ATC Integration, All-Weather Certification, Icing Standards, Crashworthiness, Noise, Heliport, Communications, Navigation	Document is available to the U.S. public through the National Technical Information Service, Springfield, VA 22161

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
UNCLASSIFIED	UNCLASSIFIED 340 170	115	

Form DOT F 1700.7 (8-72) Reproduction of completed page authorized

78 12 04 112

METRIC CONVERSION FACTORS

Approximate Conversions to Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
in	inches	*2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
		AREA		
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
		MASS (weight)		
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	tonnes	t
		VOLUME		
tsp	teaspoons	5	milliliters	ml
Tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
		TEMPERATURE (exact)		
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

*1 in ≡ 2.54 (exactly). For other exact conversions and more detailed tables, see NBS Misc. Publ. 286, Units of Weights and Measures, Price $2.25, SD Catalog No. C13.10:286.

Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
		AREA		
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares (10,000 m^2)	2.5	acres	
		MASS (weight)		
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1000 kg)	1.1	short tons	
		VOLUME		
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m^3	cubic meters	35	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
		TEMPERATURE (exact)		
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F

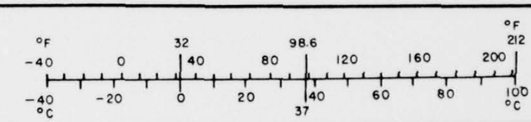


TABLE OF CONTENTS

Section			Page

Section	Page

LIST OF FIGURES

Title	Page

LIST OF TABLES

EXECUTIVE SUMMARY

PURPOSE

During the past few years, helicopter activities in the United States have been growing noticeably and various efforts have been undertaken within the FAA to develop and improve criteria and procedures pertaining to helicopter operations. In addition, various projects with the potential to benefit helicopter operations were planned as elements of different FAA engineering and development programs. Now, with the forecast of more significant growth in civil helicopter operations, it is deemed appropriate to collate all FAA development projects related specifically to helicopters into a single program. This program plan has been prepared for that purpose so as to focus the direction of FAA's helicopter-related development activities toward a single major objective.

OBJECTIVE

The overall objective of this development program is to improve the National Airspace System so as to enable helicopters to employ their unique capabilities to the maximum practical extent. This objective includes the collection of data for helicopter operations offshore, in remote areas, and in areas with high traffic density such as the Northeast Corridor.

BACKGROUND

The use of helicopters in a wide variety of applications and weather conditions has been increasing dramatically in recent years; a trend that is forecast to continue for the foreseeable future. They are a rapidly growing segment of the aviation industry, and:

- have become very important to the efficient exploration and development of energy resources in remote and offshore areas;
- are frequently used to support law enforcement, emergency medical airlift, disaster relief and other civil operations;
- have significantly increased the efficiency of the lumber industry while reducing the ecological damage resulting as a by-product of some lumbering operations; and
- have enhanced the air transportation systems by providing city-center, inter-airport and short haul industrial service.

For this segment of the civil aviation system to operate in the most productive, efficient and safe manner possible, current regulations, standards, procedures and systems must be reviewed and modified or, where necessary, new ones developed with the specific intent of optimizing civil helicopter operations while ensuring operational integration with the rest of the National Airspace System (NAS).

ISSUES

Certain major issues have been identified in this Plan as foci for study and analysis as follows:

- Navigation - The optimum means must be determined by which helicopters, operating beyond the line of sight from standard VHF navigation systems in the NAS (or extended NAS), will be able to keep track of their current location and position themselves in three dimensions (possibly also in time) with respect to important terminals, way points, landmarks, etc. A concomitant requirement involves identification of the means of surveillance by which ATC will maintain knowledge of operating helicopter's locations within the system when operating outside the range of existing radars;

- Communications - The method(s) by which information is conveyed between air and surface elements of the system must be identified where the communications link extends beyond the line of sight. The data in this case will include not only clearances, position reports, etc., but also will likely involve unique weather information critical to safe operations;

- ATC Procedures - New ATC procedures may have to be developed to encompass navigation and communications capabilities and helicopter characteristics. Special routes and procedures need to be investigated where it may be feasible to achieve improved flow of traffic involving VTOL and CTOL aircraft with widely varying capabilities; and investigations are needed to determine requirements for protected airspace, obstacle clearance, and landing/takeoff minima;

- Weather/Icing - Experience with helicopter icing is limited and needs investigation so that a satisfactory data base can be developed upon which to form new criteria. In addition, with the advancement of helicopters into "all-weather" operations, there is a need to determine the applicability of present weather data to all-weather helicopter operations and, where appropriate, to develop the means for satisfying new requirements; and

- Certification - As a result of the data packages developed in the program, new certification criteria may be developed for helicopter IFR certification and operation. A determination must be made whether these criteria will be integrated into existing FAR's or whether a new set of FAR's applying only to helicopters should be issued.

TECHNICAL APPROACH

Inasmuch as IFR helicopter operations have been approved and are being carried out on the basis of interim criteria and demonstrated performance, the program will strive not only for near-term products to improve the present operations but also will include efforts toward long-term

products for future NAS improvement. Also, as an important by-product, operational feedback resulting from the experience gained in the near-term will provide a valuable element of "validation" to the ultimate results. Near-term products have been defined as those that could possibly become available by 1979.

Since the helicopter operations development program is a collation of activities involving all functional areas of aviation, much of the development work which is being (or has been) carried out in other research and development programs has an application to the improvement of civil helicopter operations. There are other relevant programs being accomplished by the FAA as well as by NASA, DOD, and the U.S. Coast Guard. Close coordination will be maintained with these other relevant programs to avoid duplication, to benefit from their results, and to supplement them where appropriate.

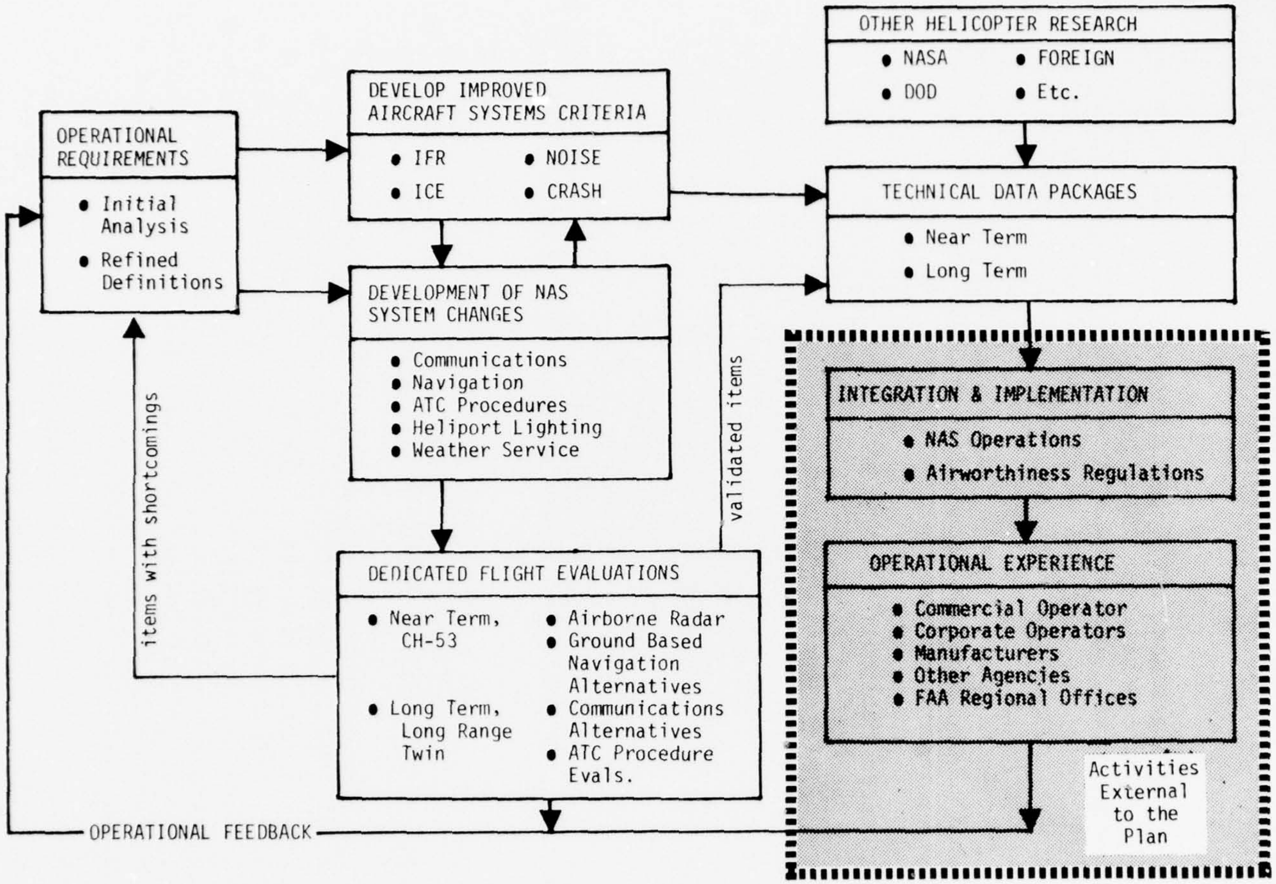
It is also recognized that much of the development work undertaken in this program for the benefit of helicopter operations will be applicable to the operation of other types of aircraft (e.g., STOL and low-flying general aviation aircraft); consequently the products of this program will be oriented toward improvement of the National Airspace System, giving due consideration, where sensible, to the need for compromise with and application to operations of other aircraft.

The overall technical approach is depicted in Figure 1. It involves several logical steps by which the technical data packages (to be produced in the form of reports) will be generated, including an iterative validation procedure to maximize the quality and practicality of the results:

- Utilizing available background data and expertise, the operational requirements associated with helicopter operations within the NAS (or extended NAS) will be initially postulated;

- Based on the operational requirements, a series of technical efforts will translate these into required improvements in both aircraft and ground elements of the NAS. First, functional requirements will be evolved and then, based on technology assessments, these will be transformed into specific equipment, procedures, criteria or standard changes or innovations. Those applicable outputs of the second effort will then be implemented on a limited scale for flight evaluation, and will be tested for operational, technical and cost/benefit acceptability;

- The FAA's CH-53 Program at NAFEC will be utilized in the near-term for these tests; a second aircraft will be used in the long-term program. Flight tests will also be conducted using operational helicopters assigned to the FAA, and, where feasible, those of commercial operators;



DATA FLOW

Figure 1. Helicopter Operations Development Plan

- The test results will indicate that the equipment, procedure, etc. either is valid or has shortcomings. If the test results are good, the subject of the evaluation will be forwarded directly to the operating activities of the FAA as a product of the program. Those items which are not validated will be recycled to the operational requirements phase for reassessment. If minor revisions/modifications would remedy the shortcomings detected in the tests, the item will be changed and reissued for re-test in the flight validation program. If the item has major deficiencies not warranting reissue, the item (together with the test results) will be reported upon, and the data package will be forwarded as a product reflecting the negative assessment; and

- The technical data packages will be transmitted to the appropriate activities for consideration as the basis for regulations, standards, criteria, etc. The results of all tasks will be integrated and will reflect the operational experience gained during the Program.

SCHEDULE

Major activities are depicted in Figure 2. These are expanded upon in the Technical Approach Section of the Helicopter Operations Development Plan.

PROGRAM MANAGEMENT

The overall management of the program will be carried out by the Helicopter Program Office, ARD-706. The Program will utilize a matrix management approach wherein various functional SRDS and NAFEC groups will manage specific projects/tasks, drawing on specifically qualified personnel and facilities as necessary from FAA, DOD, NASA, NOAA, TSC, USCG and industry. Figure 3 illustrates the Helicopter Operations Development Plan management organization.

FUNDING REQUIREMENTS

Total program funding requirements are presented below (FY $000):

	1978	1979	1980	1981	1982	1983
TOTALS	780	1,850	3,680	3,605	3,355	1,000

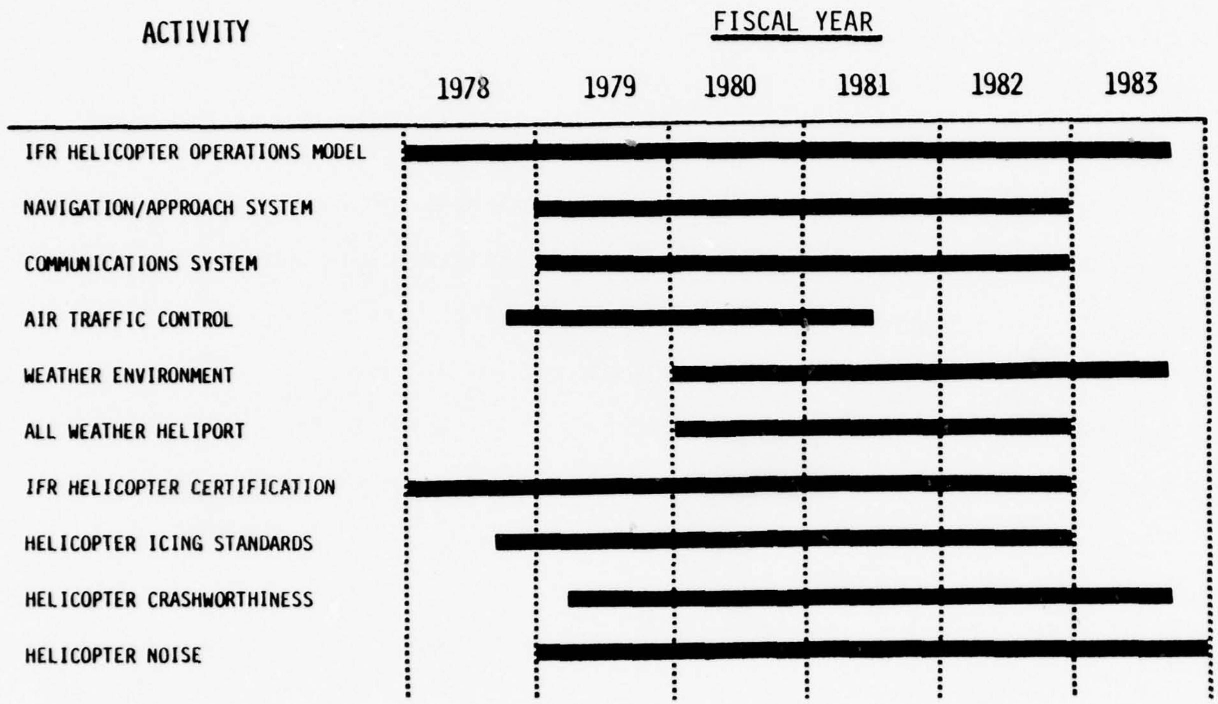


Figure 2. PROGRAM SUMMARY

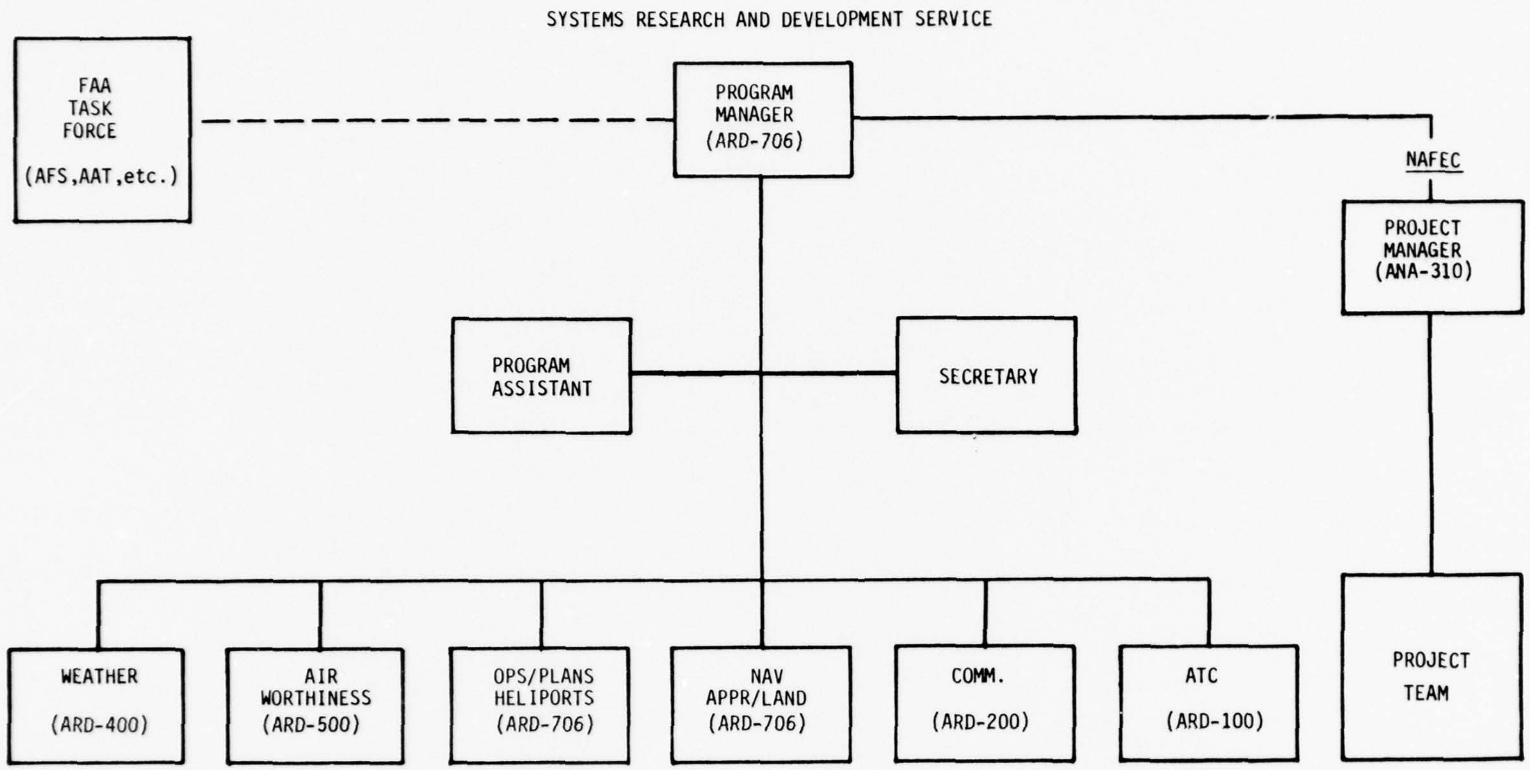


Figure 3. PROGRAM MANAGEMENT

1.0 Introduction

1.1 Helicopter Problem

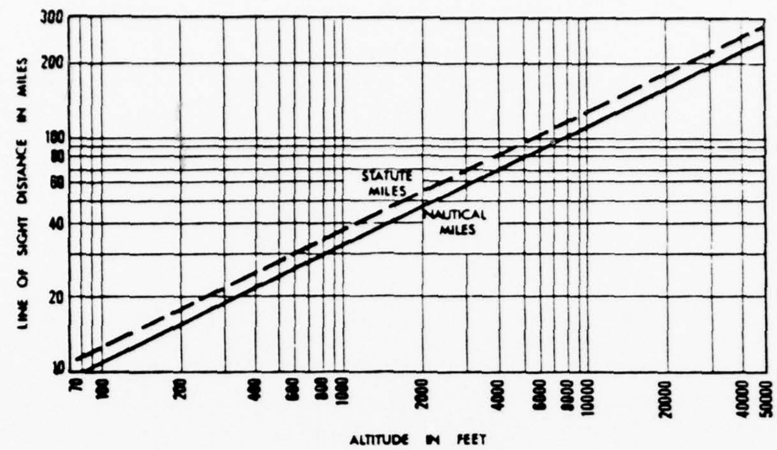
1.1.1 Need for Helicopter Evolves

Development and exploitation of energy resources in remote and offshore areas requires the operational flexibility of the modern helicopter. A similar requirement also exists in such areas as alternative priority transportation in congested metro areas, metro law enforcement, emergency medical airlift and disaster relief. In addition, the use of the helicopter can reduce the ecological impact of timber harvesting operations.

Commercial recognition of the various needs for the flexibility and versatility of the helicopter have caused the helicopter industry to be the fastest growing segment of the aviation industry. In 1976 the helicopter industry recorded an 18 percent growth. More specifically this growth is attributable to strong social and economic factors and significant advancement in helicopter technology. Major factors stimulating this growth are: the ever-increasing demand for energy; resource exploration and development, particularly in remote and undeveloped areas; the recognition of the enormous fixed capital investments required to augment and expand other modes of transportation; and finally, a growing awareness of the unique capabilities of the helicopter as they pertain to fulfilling a wide variety of society's future transportation needs. Concurrently, improvements in technology have produced a helicopter which is now very capable of entering into the Instrument Flight Rules (IFR) arena. This capability and other improved performance and operating characteristics make it an extremely competitive alternative to other modes of transportation.

1.1.2 The National Airspace System (NAS) Helicopter Problem

Current navigation aids, radar coverage, and communication systems are more effective with altitude and thus, more compatible with high performance aircraft. When conditions allow, executive and commercial transport airplanes avoid most of the severe weather at high altitudes where they are able to maximize range and true airspeed. In contrast, severe weather conditions generally dictate that helicopter and light fixed wing aircraft fly below the weather. At the lower altitudes, the helicopter can achieve maximum speed and in some cases use that speed to fly around locally severe weather conditions. Aside from weather considerations, the maximum speed of a helicopter is typically limited by "blade stall" or some similar high speed rotor characteristics. Above some given low altitude, this maximum speed decreases as altitude increases. Obviously, the higher altitude increases helicopter trip time and decreases productivity.



Plot of Line-of-Sight versus Height
(Reference: Gilbert & Assoc.)

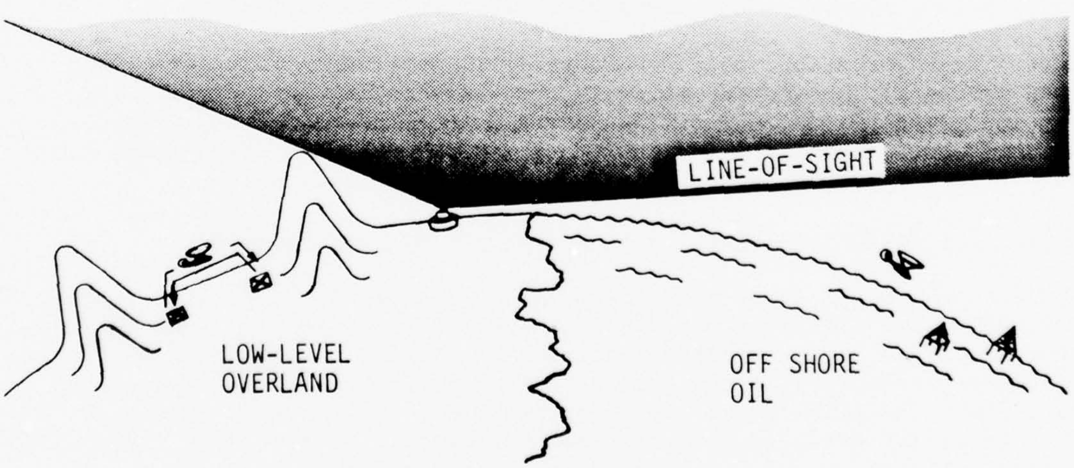


Figure 4.

LINE-OF-SIGHT LIMITATIONS
TO HELICOPTER ATC NAVIGATION AND COMMUNICATIONS

Another difference between helicopter and airplane operations involves icing conditions. Helicopters are typically unable to fly up and out of icing. If anything, they would fly down and out, and in extreme condition they might land in a farmers field.

On the approach to a landing, the airplane and helicopter are more obviously different. The helicopter does not need the runway and all the facilities of an airport serving fixed-wing aircraft. It similarly does not need the same ATC constraints developed for airplanes in the terminal area. The need to operate from heliports plus the ability to fly vertically, hover, etc., define one of the major candidate areas for investigation.

Figures 4 and 5 explore and illustrate the Line of Sight (LOS) communications and navigation problems which evolve when the helicopter is operated so as to take advantage of helicopter capability while conducting required remote and offshore operations.

In summary, many helicopter operations require that the aircraft be operated at altitudes which are considered very low by comparison to most airplane standards. The ATC system was not designed for IFR operations at these altitudes and current experience has confirmed the need to provide low altitude coverage to more fully accommodate helicopters.

1.1.3 Airworthiness Criteria Problem

At present no definitive standard exists for the certification of helicopters for operation in the IMC environment. Current certification is based on a document which has come to be known as the "Interim Airworthiness Criteria for Helicopter Instrument Flight". This document was developed in about 1960 and allows helicopters to be certified for IFR operations, but in many areas these criteria are inadequate and manufacturers are required to demonstrate compliance with FAA requirements by demonstrating "equivalent safety".

The current interim standard has not been substantially updated since the early 60's and has been the subject of criticism by the industry as not representing the minimum criteria and as not being realistic based on current technology. Improvements in basic helicopter stability characteristics and related stability augmentation concepts have afforded an increased capability for helicopters to expand into the IMC environment. Control systems and display technology have advanced to the point that application of the "interim standard" in its current format is somewhat difficult to apply, and when warranted, there are no explicit provisions for providing compensating credits for tradeoffs between control automation and display sophistication.

Crashworthiness and icing standards are generally treated the same way. Helicopters are asked to provide "equivalent safety". The solution is the same as for the ATC problem. The related FAR's must be developed or modified to specifically detail helicopter criteria in every relevant area.

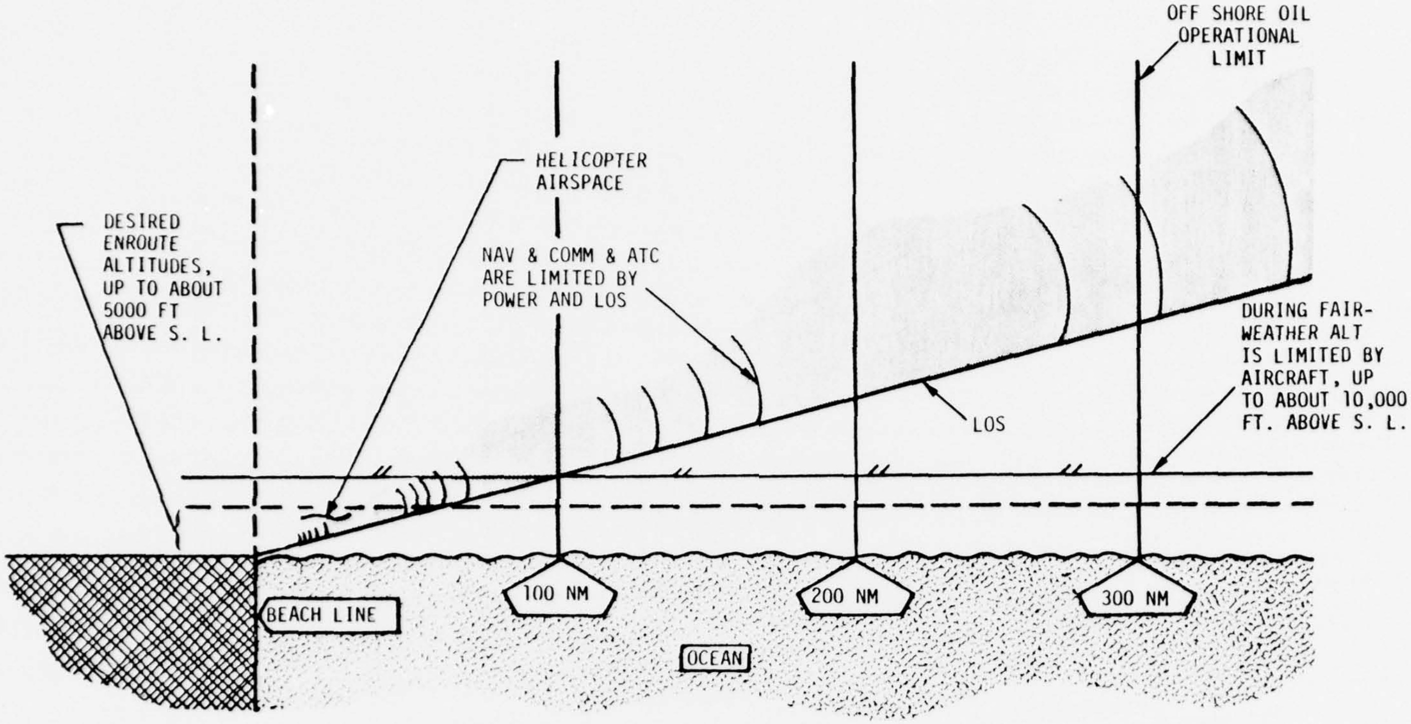


Figure 5. CURRENT EAST COAST ATC, COMMUNICATION, NAVIGATION AND AIRCRAFT CONSTRAINTS.

1.1.4 The Systems Integration Problem

The parts of the problem which fall under airworthiness address the aircraft itself while other parts of the problem involve providing an adequate operational environment for the vehicle. The need to achieve a timely and optimum resolution of all parts of the problem in turn dictates that the helicopter-related FAA activities be combined and treated as a classic system integration effort.

The decisions to implement developments from this program, and decisions regarding the manner in which they may be implemented, must be made subsequently and separately when consideration is given to other factors such as administration policy, the budget, manpower, or need for specific types of service, etc.

Because of this circumstance, this program must proceed to address technical problems and seek solutions which have potential for being integrated into an improved National Airspace System while related implementation decisions are made separately.

1.2 Program Objectives

The overall objective of this development program is to improve the National Airspace System so as to enable helicopters to employ their unique capabilities to the maximum practical extent. This objective includes the collection of data for helicopter operations offshore, in remote areas, and in areas with high traffic density such as the Northeast Corridor.

Specific objectives of the development plan are to define those equipments, helicopter characteristics and operational procedures which will yield:

- Navigation and communication systems which support operations to remote sites, offshore oil rigs, city center-to-city center, and airport-to-city center within the NAS-ATC system.

- ATC procedures and practices for IFR-ATC operations to remote sites, offshore oil rigs, city center-to-city center, and airport-to-city center within the NAS-ATC system.

- Low altitude weather forecast of potential hazardous icing conditions as well as improved reporting of weather enroute and at remote sites.

- Heliport design criteria which will allow the maximum safe reduction in visibility minima under obscured conditions.

- Helicopter certification criteria and certification procedures which in turn will
  - allow safe all weather operations in the NAS environment
  - provide for improved crashworthiness of civil helicopters
  - minimize the potential negative impact of helicopter noise on helicopter crews, passengers, and operational procedures.

1.3 Critical Issues

As the Helicopter Operations Development Plan proceeds, certain critical issues must be considered:

- Should present VOR/DME-TACAN Navigation Aids (NAVAIDS) be extended to cover the proposed helicopter operating areas (i.e. locating NAVAIDS on Texas Towers) or, should newly available over-the-horizon navigation systems such as LORAN-C, OMEGA/VLF, Inertial Navigation and, when available, GPS, be integrated into the present National Airspace System? Each approach offers unique capabilities, conceivably, a combination may offer the optimum solution.

- Should the present VHF and UHF air-ground communication system with its Line-Of-Sight (LOS) limitation be extended by "brute force" to cover the proposed helicopter operating areas, or should an alternate technique such as HF, VLF, satellite, etc., be implemented and overlaid onto, and made part of, the present communications system?

- An assessment of benefits and costs of alternative solutions is necessary to support decisions for selection of the most cost effective Communication/Navigation Systems which will enhance flight safety.

- Based upon the navigation and the communication systems selected, what ATC procedure changes must be developed to eliminate any unnecessary spacing constraints and allow a minimum descent altitude (MDA) of 200 feet and a minimuum enroute altitude (MEA) of 500 feet above obstacles.

- There is a need for prompt determination of those parameters, functions and definitions describing the basic certification requirements for reliable and effective helicopter icing protection systems. This information is needed to provide for the issuance of an interim standard (as soon as practicable) that provides guidance for test, evaluation and reliability criteria for helicopter operation in icing conditions.

- Should the present system of Federal Aviation Regulation (FAR) be modified so as to fully integrate specific consideration of the helicopter in each revised document, or should all helicopter criteria be grouped under a new and separate series of FAR's?

1.4 Program Technical Approach

The Helicopter Operations Development Plan is founded upon the recognition of three facts:

- The helicopter possesses a number of characteristics which make it uniquely different from other conventional aircraft.

- The characterisitics of the NAS, as related to all-weather operations are currently more favorable to the flight characteristics of the airplane.

- It is appropriate for the FAA to consider modifying the ATC system and related certification regulations to specifically recognize the helicopter's special characteristics and to additionally expand the NAS so that the helicopter can operate more efficiently.

The technical approach embodied in the program primarily involves investigations into:

- Suitable long range navigation and communications coverage for low altitude operations under ATC within the NAS.

- Suitable ATC procedures for use with current and future improved communications and navigation systems.

- Specific FAA certification criteria and the means of compliance for demonstrating that a given helicopter (with included equipment) is suitable for all-weather operations.

- Specific certification criteria against which to design and demonstrate all-weather heliports.

The program is organized to produce near-term, interim products which will be used to accomplish improvements in present helicopter operations. Such improvements will be given priority when they offer an increase in safety or an increase in operational utility. A NAFEC flight program and an IFR handling qualities criteria review are two such near term programs. Near-term programs are defined as those programs which will yield products by 1979.

The results of longer term program tasks will be integrated with the near term products as they become available. All products will be presented in the form of reports based upon review and analysis of flight experience or based upon analytical studies.

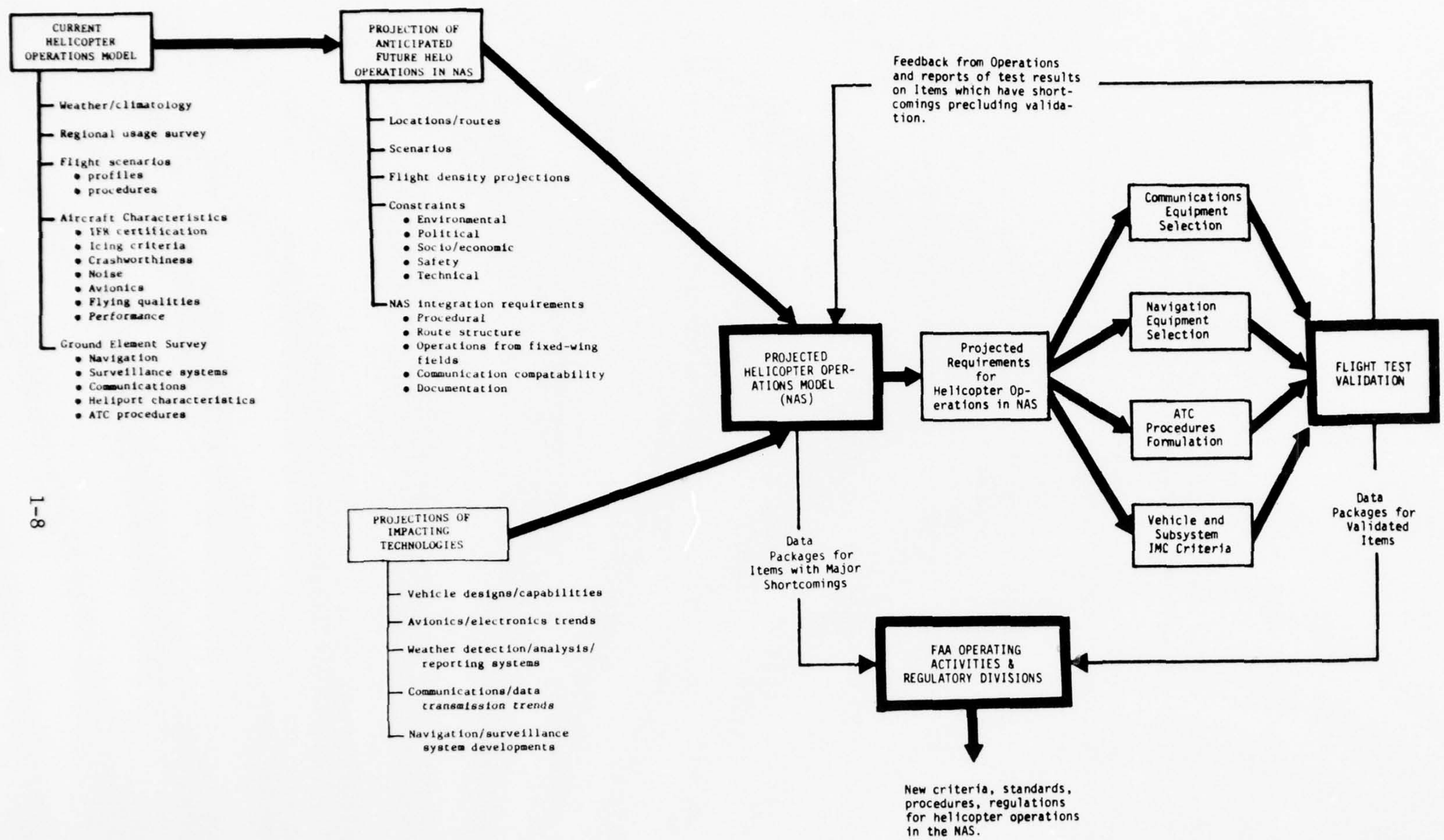


Figure 6. Development and Application of the Helicopter IFR Operations Model.

1.5 Program Structure

1.5.1 General

This plan provides the focus for a coordinated FAA helicopter research and development (R&D) effort. The plan addresses the need for helicopter research in support of present and projected requirements through 1983 and encompasses those technologies which are the development responsibility of SRDS. The program is structured to provide concurrent development in ten discrete areas, under two major subdivisions:

- NAS Improvements
  - Helicopter IFR Operations Model Development
  - Navigation System Development
  - Communications System Development
  - Helicopter Air Traffic Control
  - All-Weather Heliport
- Airworthiness Criteria (Documentation and Procedures)
  - IFR Helicopter Certification
  - Helicopter Icing Standards
  - Helicopter Crashworthiness
  - Helicopter Noise Characterization

1.5.2 Systems Approach

The systems approach is reflected in Figure 6 which is an expansion of Figure 1 to emphasize the development and utilization of a data base referred to in Figure 6 as the "Current" and "Projected" Helicopter Operations Model. When developed, this model will provide the common or central point from which all unique requirements can be developed. That is, communications system requirements and navigation system requirements will be developed from a common statement of operational need (derived from the model) for current or projected helicopter operations. This approach will provide maximum opportunity for all program elements to quickly and efficiently evolve synergistic improvements.

This operations model will be developed for the four areas in civil helicopter aviation which are emerging as requiring advanced operational concepts for all-weather operations:

- To offshore oil rigs
- From major airport to large hub city centers
- From city center to city center
- Low level/overland/remote site to remote site

In all of these areas, there are short-term and a long-term operational requirements.

1.6 Interagency Participation

In order to keep costs at an absolute minimum, this program plan is predicated upon maximum utilization of facilities and ongoing and planned R&D efforts of other Government agencies. In support of this effort, the following assumptions are made:

- Wherever possible, joint programs will be initiated where common objectives are indicated in order to preclude costly duplication of efforts and facilities.
- Because established program objectives share a common or related interest with other Government agency projects, the program plan does not anticipate the establishment of any additional FAA facilities other than test aircraft.
- Effective time scheduling will be based upon availability of Government facilities such as NASA/DOD/NRC, etc. Therefore, advanced detailed coordination with these facilities will carry a high priority for action.
- That a Government aircraft (helicopter) will be available for testing. NASA and the Army have test aircraft on hand. NAE has a flight simulator. The Air Force and Navy have suitable aircraft for testing presently in their inventory. All of these sources should receive consideration in satisfying this requirement.
- That the FAA will be able to capitalize on test programs of other agencies by establishing and supporting a free flow of interagency test information.

NASA-Ames has recently been designated as Lead Center for NASA's helicopter research programs. It is expected that close coordination with NASA will be effected in all areas of research in order to maximize joint agency efforts. The FAA's Flight Simulation Branch located at Ames would play a part in both coordination and implementation of this plan.

It would be presumptuous to delineate specific facilities requirements of other governmental agencies without taking into consideration their program requirements and the time phasing of those facilities relative to their programs. To define a specific facility at this juncture would also constrain the flexibility that is essential in accomplishment of the program objectives. Facilities utilization will be the subject of interagency program negotiation.

However, it would be fruitful to define in general terms facilities requirements relative to the major goals defined in the plan. A listing of these facilities by goal giving the location and major agency of interest is presented in Table I.

1.7 Major Milestones

The major milestones of all program elements are summarized in Figure 7.

GOAL	FACILITY	AGENCY
IMC	Bell 205 Flight Simulation Variable Stability	NAE (Canada)
	Flight Simulator for Advanced Aircraft (FSAA)	NASA-Ames
	Vertical Motion Simulator	NASA-Ames
ICE	Lewis Icing Tunnel	NASA-Lewis
	7 x 10 Wind Tunnel	NASA-Ames
	Ottawa Spray Rig	NRC
	CH-47 Spray Aircraft	U.S. Army
	40 x 80 Wind Tunnel	NASA-Ames
	UH-1H Icing Test Aircraft	U.S. Army
CRASHWORTHINESS	Lunar Lander Crash Test Facility	NASA-Langley
NOISE	Psychoacoustic Facility	NASA-Langley
HELICOPTER OPERATIONS	Test Aircraft	FAA/NASA/USAF/USN
ATC	Real Time ATC Simulator	NAFEC/NASA-Ames and Langley
COMMUNICATIONS	None Required Other Than Aircraft	
HELIPORT	Test Facilities	Navy-Lakehurst Navy-Patuxent NAFEC NASA-Ames DOT of Illinois
WEATHER ENVIRONMENT	UH-1H Icing Test Aircraft	U.S. Army
	WC-130 Weather Aircraft	U.S. Air Force
	Wind Shear Simulation Facilities	NASA-Ames
	Lockheed Electra Weather Aircraft	NOAA
	Climatic Data Bank of National Climatic Center	NOAA

TABLE I. CANDIDATE INTERAGENCY FACILITIES

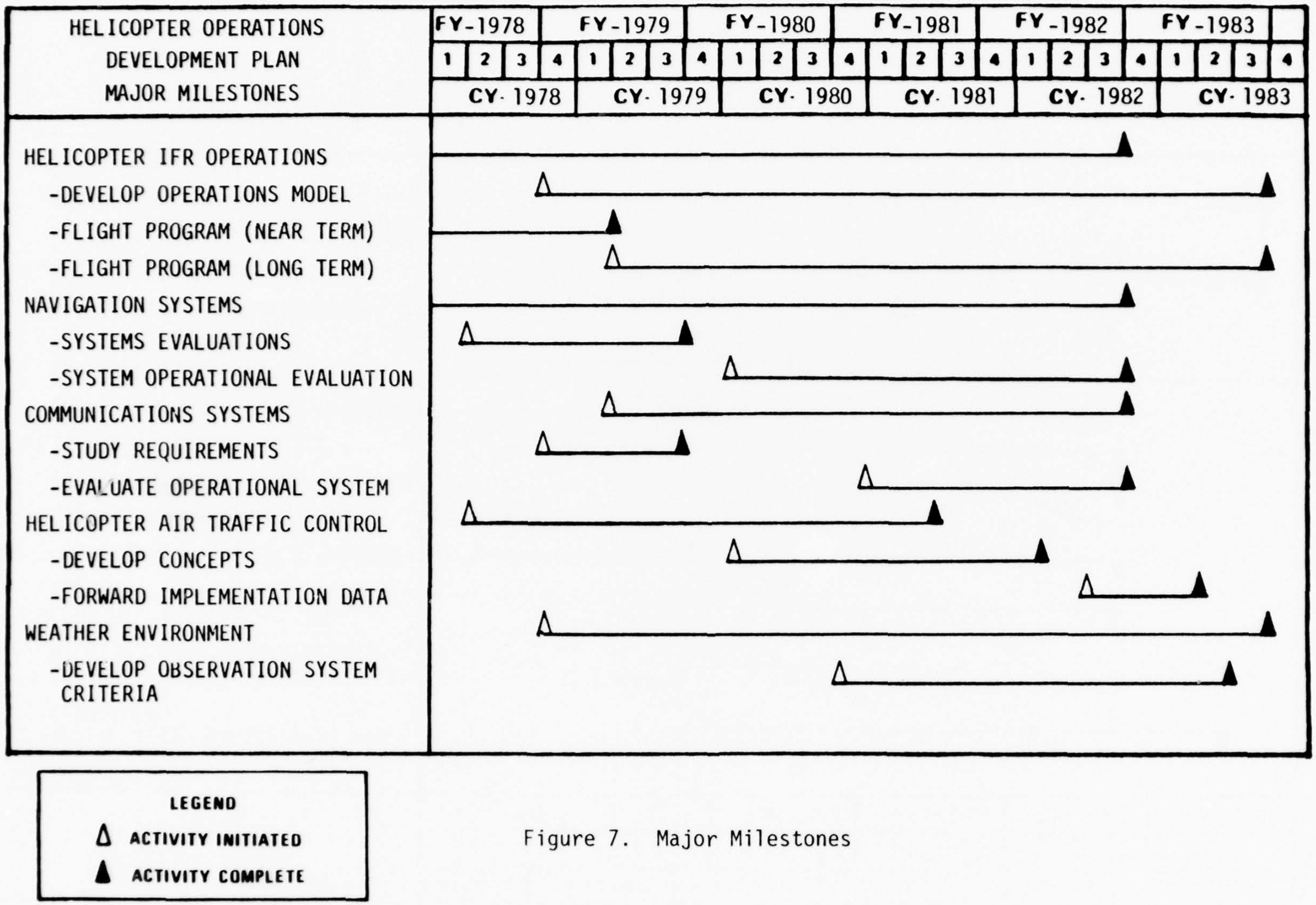


Figure 7. Major Milestones

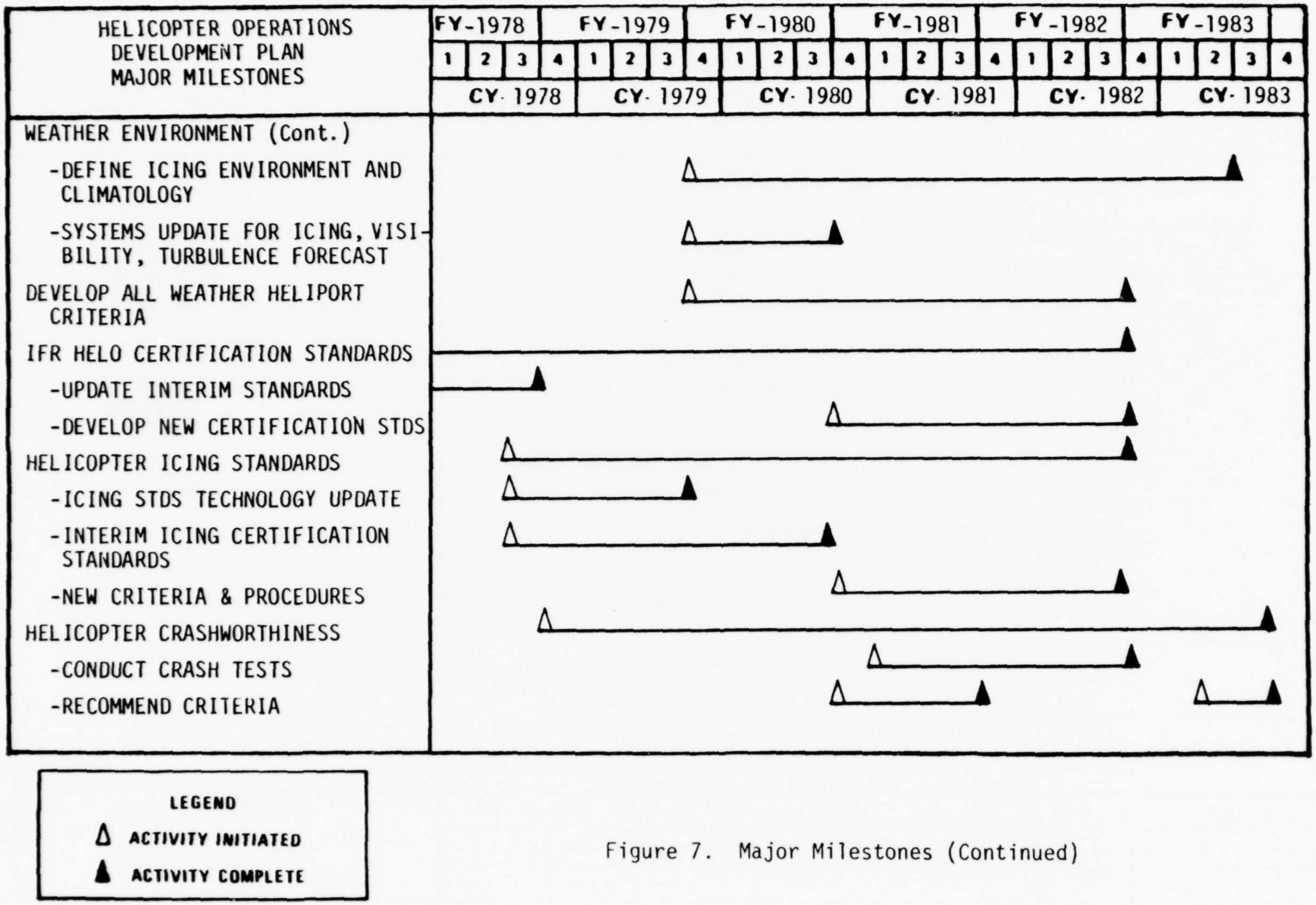


Figure 7. Major Milestones (Continued)

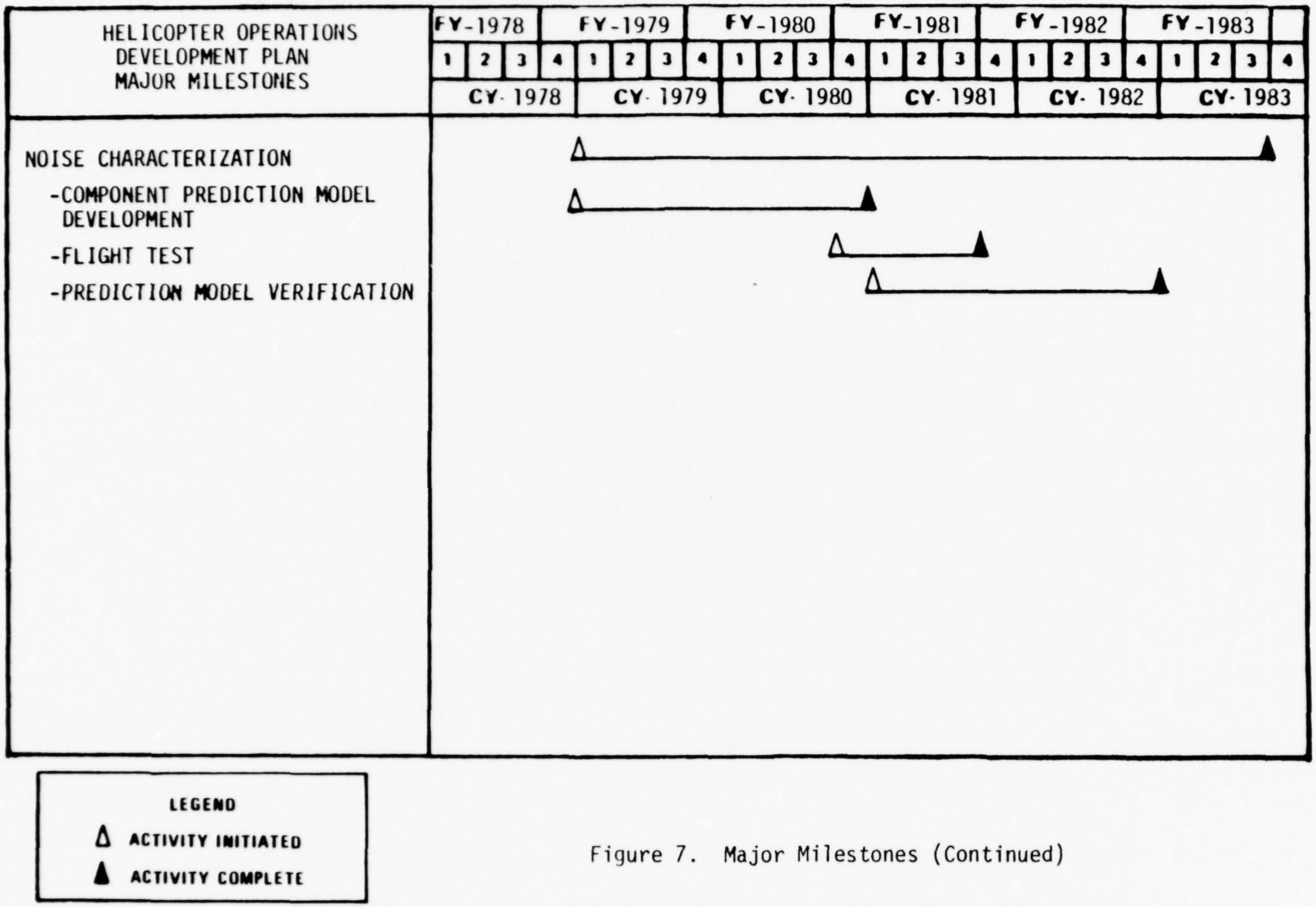


Figure 7. Major Milestones (Continued)

2.0 Helicopter Operations Development Plan Description

2.1 Helicopter IFR Operations (Model) Development

An operations model of current and potential IMC helicopter operations is essential to the accurate definition of a helicopter-capable ATC system. Such a model is also required to define many of the man-machine task relationships involved in the revision and expansion of aircraft and aircraft sub-system airworthiness criteria. In a practical sense, a model of this type is required to support the "systems concept" used to coordinate the various research and analysis efforts. The model envisioned will initially be synthesized from current data and operational experience. Flight evaluation experience, developed via NAFEC flight programs and related NASA-DOD-USCG flight programs are, in fact, a very important element in the verification of the evolving operations model. These programs additionally form a feedback loop in an integration process used in the final phases to validate concepts before significant long term ATC system changes are implemented.

2.1.1 Objective

The objective of the operations model development effort is to substantially increase general knowledge and document how civil helicopters are being used and how they will be used in the future. A greater understanding of the above will provide a common starting point from which all subsystem development efforts may be initiated. This model will be continually improved as more detailed studies of communications, navigation and aircraft airworthiness are pursued. In the long term, the operational model will insure a consistent, balanced treatment of the system integration aspects of the overall program.

2.1.2 Major Task

Initial tasks can be characterized as providing the FAA's operating services with a data bank to assist in the decision-making process of issuing or denying requests from helicopter operators. This data bank must include: technical information on operational performance of various navigation systems to augment the conventional VOR/DME system; information relative to the existence or nonexistence of adequate communication capability (HF and/or VHF) in those geographical areas of concern; and the detailed information relative to establishing ATC procedures and developing appropriate route structures.

2.1.2.1 Near Term Tasks

- Task A - Near Term Test Vehicle. Utilize CH-53 helicopter with the necessary avionics and data collection and recording devices.

- Task B - Conduct Shakedown and Preliminary Data Collection Flights. Check out instrumentation and all airborne data systems.

- Task C - Conduct Navigation System(s) Evaluation. Evaluate the operational performance, reliabililty, and accuracies of LORAN-C, OMEGA, and VOR-DME navigation systems for enroute, approach and departure.

- Task D - Communications Feasibility Evaluations. Determine existence or nonexistence of adequate HF and VHF communications signals in those areas of concern.

- Task E - Evaluate Airborne Radar. Determine the applicability of airborne weather pulsed radar (with ground mapping modes) as a navigational aid during all phases of helicopter flight operations, including enroute, approach, landing and departure.

- Task F - Radar Beacon Application Evaluation. Evaluate the requirement for the application of radar beacons and other means of target enhancement to provide for a more positive identification and acquisition of the intended point of landing.

- Task G - Determine Requirements for Obstacle Clearance Surfaces and Protected Airspace. Collect data to be applied in the development of obstacle clearance criteria for IFR helicopter operations and determination of requirements for protected airspace for enroute, approach, and missed approach procedures.

- Task H - Investigate New ATC Concepts. Provide for the inclusion of all those ingredients necessary for the development of ATC procedures, including the technique for structuring routes and providing for the establishment of adequate instrument approach procedures, including airborne radar approaches, if necessary.

- Task I - Determine Pilot/Helicopter Interface Requirements Affecting Takeoff and Landing Minima. Assess the effect of pilot workload factors, flight technical errors, and navigation systems accuracies on required landing and takeoff minima.

- Task J - Assess Pilot/Crew Workload. Include quantitative assessment of pilot/crew workload in performing Tasks C through F above, suitable for certification criteria.

- Task K - Initial Operational Model Development. Compile, analyze and model the performance characteristics of modern helicopters in conjunction with the characteristics of their operational profiles, current and future.

- Task L - Define Other Areas of Concern. Identify those other areas of concern that may be associated with helicopter flight operations as those operations might impact on safety and environmental factors.

2.1.2.2 Long Term Tasks

- Task A - Long Term Test Vehicle. Obtain a long term test helicopter which has long range and adequate size. Equip the helicopter with the necessary avionics and data collection and recording devices.

- Task B - Flight Evaluations. Conduct evaluations in all regions of CONUS involving communications, navigation, approach and landing, and ATC procedures.

- Task C - Operational Model. Complete the development of a model with performance characteristics of modern helicopters.

- Task D - MLS Evaluation. Evaluate MLS as an aid to unique helicopter approaches, landings and departures.

2.1.3 Technical Approach

The technical approach to the Helicopter IFR Operations effort will use, as a basis, the evolutionary development of an Operations Model. This operations model will include such parameters as helicopter mission requirements, flight characteristics, man-machine-task relationships, equipment configurations and weather environment. The model will be empirically developed; (1) by analyzing the results of industry-user data surveys and, (2) as the result of FAA feedback information. A near-term and a long-term flight program will allow certain equipment and ATC procedures to be evaluated. The results of these and other evaluations will aid in the definition of practical near and long term flight profiles and ATC scenarios (see Figure 6).

2.1.3.1 Operations Model

The Operations Model when developed will contain a series of operational profiles, predict how helicopters will be flown, and include characteristic data on vehicle/subsystems and operational attributes/limitations. This model will be supported by an intensive near-term data acquisition-compilation effort and a long-term refinements effort incorporating the results of FAA and other flight evaluations. The Model will be published as a collection of synoptic profiles-scenarios for the common use of all of the study efforts of Sections 2.2 through 2.10 as well as the FAA flight program. The FAA flight program will effectively be charged with continually evaluating and validating certain aspects of the model.

Five generalized operational profiles can be visualized as important to this effort. Each of the generalized profiles represent a discrete segment (or satellite operations model) in the development of the total helicopter operations model. The following profiles are considered to require advanced operational concepts for satisfactory all-weather operations:

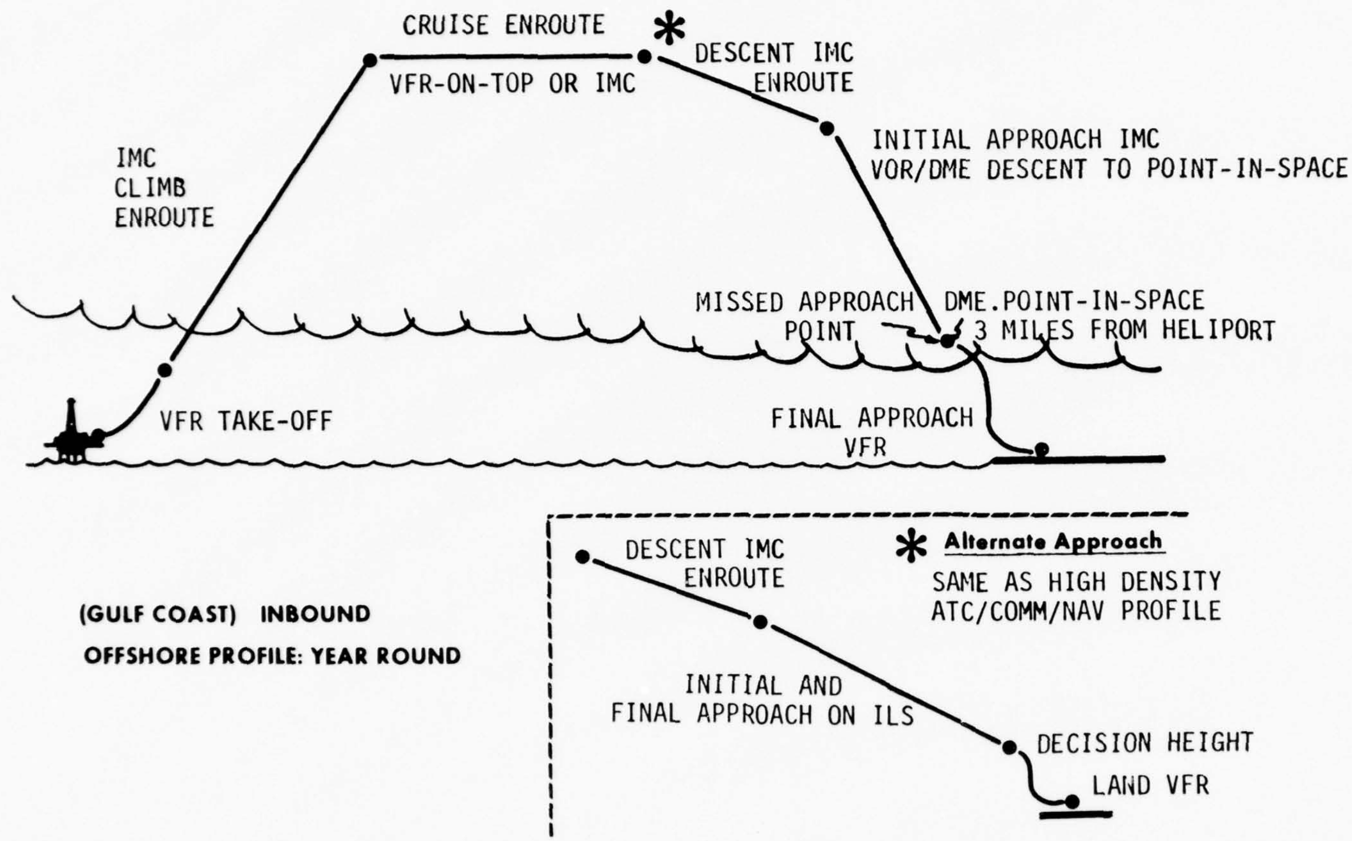


Figure 8. GULF COAST, INBOUND OFFSHORE PROFILE

- Offshore Operations. Oil and gas exploration and production in waters off the United States coastline is currently the principal factor responsible for the greatest increase in helicopter flight operations.

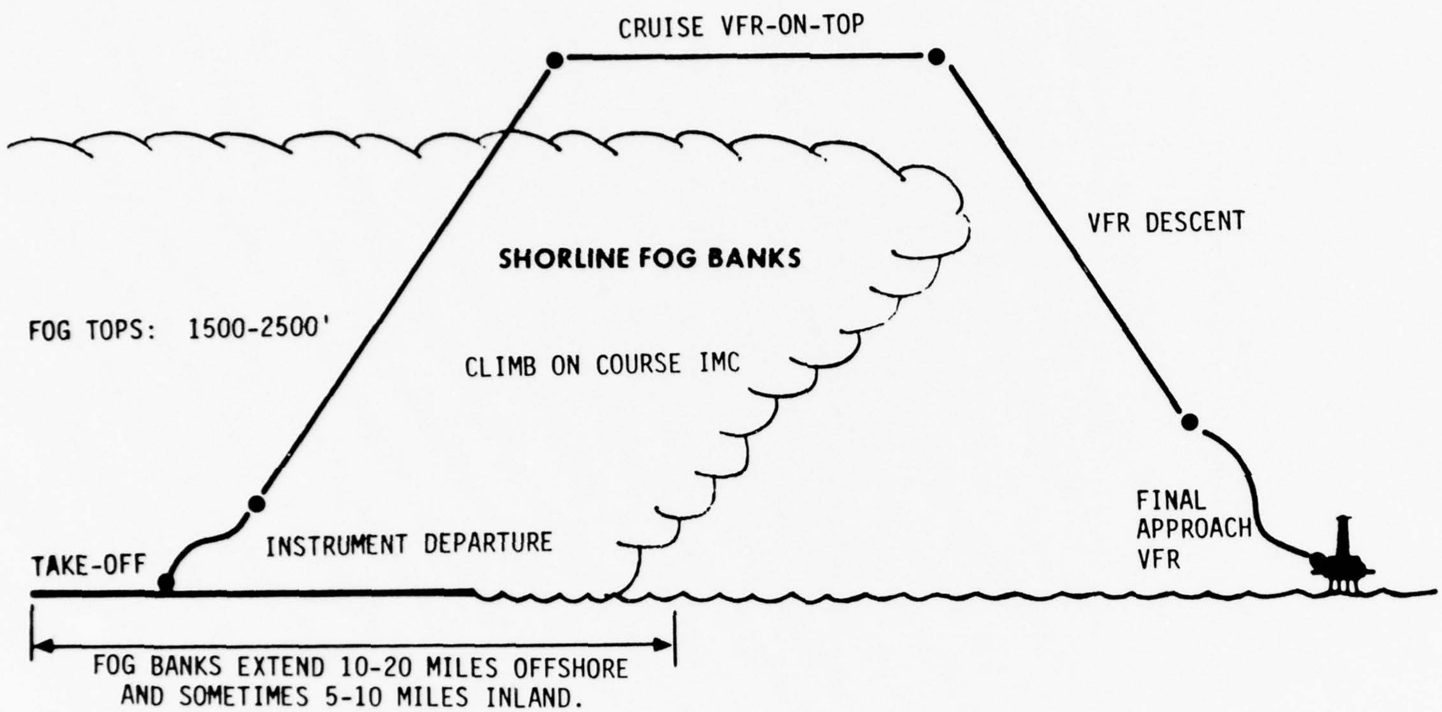
  These helicopter operations serve three basic requirements: (1) the movement of personnel on a regular shift change basis; (2) rapid logistic support for the highly expensive drilling rigs; and (3) emergency and medical evacuation services. The flight profile of the helicopter from landside to the offshore platform is unique.

  The helicopter may be required to fly at altitudes as low as 500 feet above sea level, in instrument conditions, along the entire route from landside to the offshore drilling rig. The pilot may then be required to execute a descent and approach to land on the off-shore platform (helipad). In addition, restrictions to visibility such as sea fog are prevalent and, in some areas, icing and lack of a horizon at night make it mandatory to establish the capability of civil helicopters to operate under instrument flight conditions.

  - Near-term operational approaches will use VOR- DME, NDB's and marker beacons where available. Limited use of airborne radar for offset approaches to breakout and landing is underway. See Figures 8 and 9 for current offshore profiles.

  - Operations off the coast of New Jersey call for 14 platforms with 72 to 144 daily helicopter operations through 1979. The Pacific coast and Gulf of Alaska operations will be less intense than the Atlantic. However, the requirement for IFR operations is just as important, due to weather conditions that are prevalent in those areas. It is expected that if explorations in these areas result in the discovery of significant oil and gas deposits, the number of drilling rigs and daily helicopter operations could multiply by a factor of 3; and actual energy fuel production could continue for 20 to 30 years, depending on the size of the deposits and the rate of production. It is also expected that the logistics support during this entire period would continue to be provided by helicopter operations.

  - To support IFR helicopter flight operations between landside heliports and offshore landing platforms, the Air Traffic Control system will require the following capabilities: (1) accurate navigation; (2) reliable communications; and (3) specific control procedures. Though the capability to navigate to specified accuracies and the ability to control aircraft are important, the capability to communicate control instructions and to exchange pertinent flight data (aircraft position,



(GULF COAST)

OFFSHORE PROFILE: SEASONAL TRANSITION MONTHS (January - March)

Figure 9. GULF COAST, OFFSHORE PROFILE

altitude, expected/actual departure and arrival times, weather, etc.) remains the most important ingredient of the ATC system. It is essential that the controller be able to communicate with the helicopter while enroute to and on board the offshore platform. This is necessary so that the controlling facility may issue approach, enroute, descent or departure clearances to other aircraft using the same routes and terminal areas. Routes must be established, based on enroute navigation aids, between landside and offshore landing/arrival sites. Descent, arrival, and departure procedures based on appropriate landing aids must be established that will ensure that separation is maintained between arriving and departing aircraft, for accomodating initial assignment of cruise altitudes, and requests for changes in altitude while enroute.

- Remote and Major Airport to Downtown Area Operations. A need to develop the capability for helicopter all-weather flight operations exists, not only in offshore operations but also in remote areas of the CONUS and in high-density areas (such as the Northeast Corridor). More importantly, the helicopter must be accepted as part of the complex ATC system available today. The primary requirement at major airports is establishment of a capability for independent approach, landing, and takeoff procedures.

  - To realize the maximum advantage of the helicopter's slow speed approach capability requires an independent, high angle, all-weather landing system. As with short takeoff and landing (STOL) vehicles and other aircraft capable of slow speed approaches,limiting the length of the common path will help volume productivity of successive approaches. Developing close-in helicopter approach fixes would be a logical first step in creating a high volume helicopter approach system. Independent approach paths to a close-in fix are desirable (but not always possible since interaction may occur with conventional aircraft). An important goal is to design multi-directional approach paths so that there is a continuous flow-through capability to allow for over and under interaction between helicopters and conventional aircraft.

  - Further development is required for helicopter standard operating procedures at airports. For example, if visibility allows contact with the touchdown point; flare, touchdown and roll out away from the touchdown point will allow higher landing rates.

  - While development of helicopter IFR airport procedures is important, an enhanced all-weather capability for downtown and suburban heliport feeder points is required to insure total system reliabilty.

- City Center-to-City Center Operations. The inherent flexibilty of the helicopter coupled with its increasing size and speed make it an ideal vehicle to provide a complete point-to-point air service. Unlike the airplane, the helicopter is not restricted to airport operations and, depending on demand, can provide direct City Center-to-City Center service. Additionally, the large helicopter has the capability to be a primary airport feeder vehicle. As such, it requires consideration for a priority independent approach to fulfill its objective.

  - Route Structure, communications, optimum operating altitude, noise reduction, IFR and crashworthiness certification are factors to be defined to evaluate the feasibility of these operations.

- Low Level/Overland/Remote to Remote Site Operations. Helicopters are ideally suited for and ever more extensively employed in remote site, overland operations involving geological exploration and survey, lumbering, search and rescue, agricultural spraying, logistics support, and medical evacuation missions. These operations are typically flown at low altitudes where communications and access to navigation aids are often unavailable. Program research similar to that required for offshore helicopter operations is needed to meet the demand brought about by increased activity in remote area helicopter operations.

- Other Operations. Although military helicopter operations include a risk factor expected in these type operations, there is a similarity of end products in that a mission completed is no different than the on-time regularity required of commercial aviation; therefore, a thorough analysis of compatibility between civil and military concepts, techniques, and procedures is a natural area for research to consider all possibilities.

  - In addition, a variety of helicopter operations outside of the oil rig, major airport, and city center-to-city center warrant consideration. Agriculture, special applications, and industrial applications need a similar detailed analysis and development.

2.1.3.2 Flight Program

The Helicopter IFR Operations effort requires a dedicated flight test program to properly evaluate candidate systems and procedures. Specific flight tests must be designed to closely emulate the stated operational profiles and thereby assure acquisition of all data necssary to accomplish the flight tasks set forth in Section 2.1.2. The flight test program will be augmented by appropriate special facilities testing and simulations designed to specifically evaluate hardware/software items and by development of any required operational procedures necessary to assure flight safety.

The flight program will consist of near and long term efforts as shown in Figure 10. The near and long term efforts will require different test vehicles and will incorporate related data previously developed by military, industry and other civil agencies.

2.1.3.3 Near Term Test Aircraft

A CH-53 helicopter was obtained through a working arrangement with NASA and is being utilized in the near term flight test program currently underway at NAFEC, Atlantic City. Avionics necessary to acquire and record all data required for test objectives were identified. Since several systems are scheduled for evaluation, the total effort is being conducted in phases. Phase I configuration is as listed below.

CH-53 PHASE I Avionics Configuration
SINGLE SYSTEMS

VHF Communications Transceiver
HF Communications Transceiver
ADF
DME
RCA PRIMUS 40 (or PRIMUS 50) weather/ground mapping radar or
Bendix RDR-1400 weather/ground mapping radar

DUAL SYSTEMS

VHF Communications Transceiver
Radar Altimeters
VOR/DME
ATC Transponders with Mode C capability
ADI and HSI displays
Sperry HELCIS flight director system
Collins NCS-31 RNAV and communications control system

Dual stability augmentation systems (SAS) are available, however, approach/navigation coupling is not available.

Potential additonal systems for incorporation in follow-on phases of flight test evaluations are defined below.

CH-53 PHASE II Avionics Systems Changes
ADDITIONAL SYSTEMS

RCA color airborne radar
Bendix color airborne radar
TACAN/RNAV
Teledyne TDL-424 LORAN-C receiver
VLF/OMEGA receiver
MLS receiver
ARINC NET

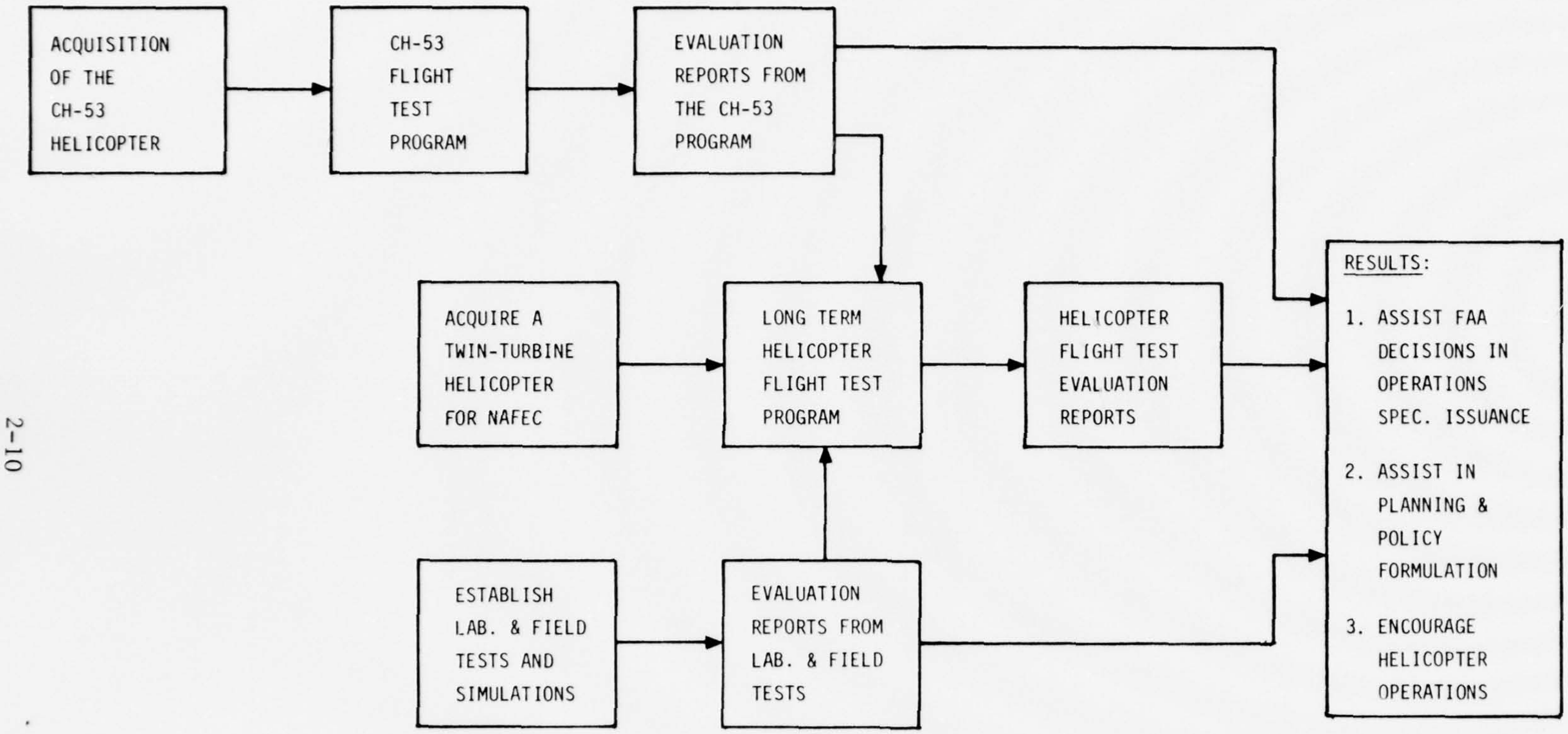


Figure 10. FAA IFR HELICOPTER FLIGHT OPERATIONS PROGRAM

The CH-53 will be equipped with a digital data recording and handling package which will provide for rapid retrieval and analysis of technical information. The following will be recorded:

- Aircraft position determined by navigation system under evaluation
- Cross-track and along-track errors
- Aircraft altitude determined by radar altimeter
- Navigation system signal-to-noise ratios, computed navigation values, equipment performance state
- Time
- Airborne radar data by photographs of CRT display
- Weather environment (including Sea State)
- Pilot comments

Reduction and analysis of all data (electronic, photographic and manual) will require development o˙ software techniques that will give consideration to a "quick look" capability. Analysis must consider, quantitatively and qualitatively, the validity of test procedures, equipment conditions, and address certification and regulation aspects.

2.1.3.4 Long Term Test Aircraft

A test aircraft is required for the long term program. This test aircraft is required for technological, operational and procedural verification. Considering the expense of research and testing which must be done, an aircraft with a large useful payload is necessary in order to support the myriad of essential test equipment and personnel.

In view of identified test requirements, objectives, and goals, the minimum essential technical and operational aircraft requirements are as follows:

- MULTI-ENGINE. At least two engines are essential for offshore operations to increase safety during over water Instrument Meterological Conditions (IMC) and heavy load operations.
- CAPACITY AND VERSATILITY TO ACCOMMODATE:
  - Data Acquisition Systems - The actual hardware used to collect and process test data.

- Redundant Display - To evaluate the safety benefits of having two complete sets of instruments and controls for an aircraft with two pilots. To compare data on a particular test from different sources of collection. To test different types of navigation or other equipment to determine which actually works best in the environment being tested.

- Navigation - Space for various types of navigation equipment, such as LORAN, OMEGA, INS, RNAV, etc.

- Communication - Capacity for special test equipment in addition to normally required euqipment.

- Stability Augmentation - Improves data acquisition, reduces pilot workload and fatigue, and greatly enhances the safety of IFR flight.

- Radar - Color display digital radar systems will be evaluated when available.

• SUSTAINED OVERWATER OPERATIONS OF NOT LESS THAN 5 HOURS DURATION. One test objective calls for communications that support low altitude flight operations out to 300 miles off the coast. This distance plus the IFR fuel reserve requirement result in the planning figure of 5 hours. This requirement also means that the test aircraft must be able to carry test equipment and personnel in addition to auxiliary fuel tanks necessary for the 5 hour endurance.

Line support including some minor maintenance will be accomplished by NAFEC personnel. Major maintenance will be done under agreement with another facility established for handling such maintenance.

2.1.3.5 Model Becomes Data Base

As the result of analysis of sufficient flight test data, it is expected that a data base will be provided to the operating services of the FAA that will allow for the establishment of certification criteria and development of operational procedures concerning helicopter IFR operations in offshore, remote, and high traffic density areas. This data base would be provided in report form designed to be most useful in the determination of the following:

• Navigation system accuracies to maintain a flight path of ±4 NM either side of a designated centerline (route), to offshore distances of up to 300 NM, with 95 percent reliability.

• Accuracy and reliability of all systems and subsystems to meet the certification requirements of Advisory Circular 90-45A.

- Accuracy and reliability of airborne weather/ground mapping pulsed radar, in terms of the existing criteria for enroute navigation and published approach procedures, as well as for establishing criteria for developing new procedures.

- VHF and HF communication coverage plots will be constructed and presented for each area of concern. The establishment of positive air traffic control procedures is predicated on reliable air/ground/air communications (to distances of up to 300 NM offshore and to a minimum descent altitude of 200 feet).

- The establishment of a baseline for Terminal Instrument Procedures (TERPS) criteria for helicopters.

- Pilot workload (cockpit) and flight technical error (FTE) during all phases of flight in offshore, remote, and high traffic density areas.

2.1.4 Near-Term Decision Points and Program Management

The near-term decision points for the Helicopter IFR Operations Program are shown in Table II. The Program Management will be as set forth in Section 4. The program schedule for the Helicopt.: IFR Operations Program is outlined in Figure 11.

2.1.5 Funding Requirements

Helicopter IFR Operations Development Program Funding Requirements (FY, $000):

	1978	1979	1980	1981	1982	1983
Total	300	500	700	350	350	250

DECISIONS TO BE MADE	OFFSHORE NEW JERSEY	OFFSHORE NEW ENGLAND	NORTHEAST CORRIDOR	ORGANIZATIONAL & MANAGER	
Recommendation on the use and approval criteria of Omega as a certifiable helicopter navigation aid	3/79	1979*	1979	ARD-706	Tracy
Recommendation on use and approval criteria of Loran-C as a certifiable navigation aid	3/79	1979	1979	ARD-706	Tracy
Recommendation on MLS use and procedures for Loran-C	1979	1979	1979	ARD-706	Adams
Recommendation on the use and approval criteria of airborne radar as an approach aid by helicopters	3/79	1979	-	ARD-706	Tracy
Recommendations for optimum offshore ATC operations	5/79	1979	-	ARD-150	O'Brien
Recommendation on helicopter terminal instrument procedures (TERPS)	10/79	10/79	10/78	ARD-150	O'Brien
Recommendation for offshore communications system for low-level helicopter operations	3/79	1979	1979		

*Date is dependent on court decisions regarding oil drillings in the George's Bank area off the New England coast

TABLE II. SRDS DECISION POINTS (NEAR TERM)

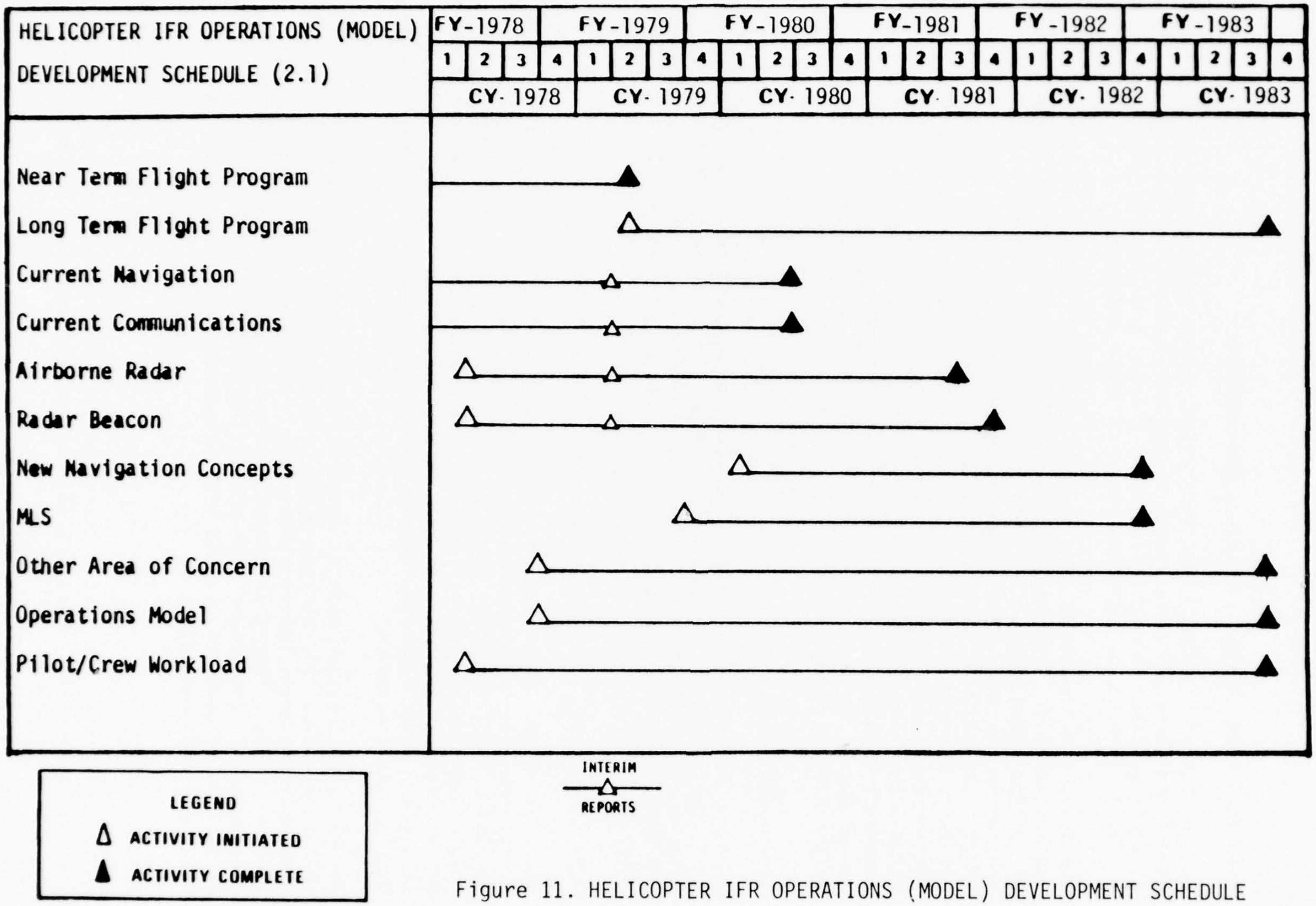


Figure 11. HELICOPTER IFR OPERATIONS (MODEL) DEVELOPMENT SCHEDULE

2.2 Helicopter Navigation System Development

For the purpose of this plan, navigation system development for helicopters includes the development of systems, procedures and criteria for aircraft guidance during all modes of flight, including enroute, non-precision terminal maneuvering, and precision approach.

The current NAS is based upon the use of VOR/DME Navigation Aids with a nominal range of 50 nautical miles. ATC procedures require an aircraft to utilize these aids to navigate the air route structure while controlled in the NAS. The line-of-sight reception characteristics of VHF/UHF signals will preclude the use of these established NAVAIDS for off-shore low altitude helicopter operations. Other remote operations involve inadequate numbers of transmitters and/or poor coverage due to terrain features. City center-to-city center operations may involve temporary NAVAID signal loss due to low altitude terrain masking. The actual degree of inadequacy of VOR/DME coverage is dependent upon the flight profile required (see Section 2.1).

2.2.1 Objective

The objective of the Helicopter Navigation System Development effort is to evaluate and define navigation systems for utilization in low-level helicopter operations within the NAS, and to evaluate and define approach and landing systems suitable for precision guidance in the terminal areas.

2.2.2 Important Considerations

The present ATC system has been developed primarily for overland U.S. operations with an assumption that a Navigational Aid (and possibly a precision landing system) would be available at principal way points and flight termination points. Line-of-sight limitations of existing NAVAIDS do not meet the requirements for accurate navigation of a low flying helicopter in off-shore or remote site operations and sometimes in high density traffic areas.

Further consideration must be given to the determination of what additional navigation systems might be necessary to safely operate the helicopter in high density traffic areas in the enroute, terminal and approach modes. Flight experience and general data are required to allow assessment, in conjuction with similar information of alternate navigation systems, of the MLS and Airborne Radar Approach roles in helicopter IFR operations.

2.2.3 Issues

As the Helicopter Navigation System Development effort proceeds, related critical issues must be identified and addressed. Three of these issues are discussed below.

2.2.3.1 Critical Issues

- Should present VOR/DME Navigation Aids (NAVAIDS) be extended to cover the proposed helicopter operating areas (e.g., locating NAVAIDS on Texas Towers) or, should newly available over-the-horizon navigation systems such as LORAN-C, OMEGA/VLF, Inertial Navigation, and when available, GPS, be integrated into the present Navigation System. Each approach offers unique capabilities or, conceivably, a combination may offer the optimum solution.

2.2.3.2 Significant Issues

- Determination of MLS and Airborne Radar Approach applicability to IFR helicopter operations and impact on ATC procedures.

- Cost-effectiveness of alternative solutions. An assessment of benefits and costs is necessary to support a decision for the selection of the most suitable Navigation System which will enhance flight safety.

2.2.4 Major Tasks

The following tasks will be repeated for near and long term efforts:

- Task A - Study Requirements. Define the technical and operational requirements for navigation systems which can provide accurate navigation for low altitude helicopter operations out to 300 nautical miles offshore, for remote site operations and for high density traffic operations in enroute, terminal and approach modes. Performance characteristics related to propagation anomalies, reliability and availability and impact on current ATC procedures and equipment will be examined to establish new criteria and compliance with currently applicable criteria.

- Task B - Specify Equipment. Based upon the requirements developed above and test evaluations of navigation systems, specify equipment which will meet requirements for all modes of helicopter operations.

- Task C - Evaluate Operational Capability. Demonstrate, evaluate and verify total system capability to accurately perform navigation tasks and define implementation criteria to suit helicopter applications.

2.2.5 Technical Approach

The technical approach to the Helicopter Navigation System Development effort is two phase in nature: near term and long term.

Near term effort will consist of:

- Evaluation of the following systems to determine their suitability for low level helicopter operations and to collect data for use in developing terminal approach procedures and defining airspace requirements.
  - ILS, VOR-DME,and NDB Systems
  - Loran-C (Teledyne TDL-424, TDL-711) Systems
  - OMEGA/VLF (GNS-500) Systems
  - Airborne Digital Radar (RCA Primus 50, Bendix RDR-1400) Systems
  - Microwave Landing Systems
- Coordination with USCG, user groups, and related programs. The USCG is operating an H-3 Helicopter recording LORAN-C data in a manner compatible with the FAA tests. The FAA and USCG data must be merged where possible. Helicopter operators are currently using airborne radar as an approach aid for low visibility/ceiling operations at offshore oil platforms. Effectiveness of this technique should be recorded to supplement FAA flight test data. Related programs such as the Microwave Landing System and the Systems Test and Evaluation Program (STEP) will produce other data which may be utilized.

Long term effort will consist of:

The long term program will define, verify and establish navigation systems design and implementation criteria in support of helicopter offshore, remote and high density area operations and for integration of new navigation systems into the current NAS.

2.2.5.1 Data Aquisition

As a subset of the above efforts, data for the following efforts must be collected, analyzed, and reported.

- For VOR/DME Airborne System.
  - Determine station(s) availability for off-shore operations and derive LOS limit.
  - Measure signal quality at low flying altitudes (1000 feet to surface).
  - Derive signal availability/statistics for above item.
  - Analyze suitability of interface between VOR/DME and LORAN-C/VLF/OMEGA at LOS limits.

- Conduct analysis of locating VOR/DME-TACAN Systems on Texas Towers, oil platforms, etc., to support operations out to 300 nautical miles.

- Draft recommendation for expanding implementation of VOR/DME systems, if applicable.

- <u>For LORAN-C Airborne System</u>

  - Determine level of repeatable accuracy out to 300 nautical miles flying at various altitudes between 1000 feet and the surface.

  - Determine sunrise and sunset effects as related to above item.

  - Measure signal quality at low flying altitudes (1000 feet to surface).

  - Develop and test coordinate conversion system to provide bearing/distance to way points.

  - Define airborne antenna and antenna location requirements.

  - Determine suitable levels of hardware sophistication, cost, reliability, and maintainability.

  - Determine rotor modulation effects.

  - Establish pilot workload factors.

  - Develop and recommend TERPS with LORAN-C.

  - Evaluate display and instrument alarm indicators.
    - Loss of station(s).
    - Recovery of station(s).
    - Hardware failure (automatic and manual).

  - Determine installation requirements.

  - Estimate pilot training requirements.

  - Recommend certification requirements.

  - Define ground monitor system requirements.

  - Prepare and report recommended guidelines for FAA implementation of LORAN-C for use by helicopters.

- <u>For VLF/OMEGA Airborne System</u>.

  - Determine level of repeatable accuracy out to 300 nautical miles flying at variable altitudes between 1000 feet and the surface.

- Determine sunrise and sunset effects as related to above item.

- Measure signal quality at low flying altitudes (1000 feet to surface).

- Conduct signal reliability tests and derive availability statistics.

- Develop and test coordinate conversion systems to provide distance/bearing to waypoints.

- Define airborne antenna characteristics and siting requirements.

- Determine rotor modulation effects.

- Evaluate display and instrument alarm indicators.
  - Loss of station(s).
  - Recovery of station(s).
  - Hardware failure (automatic and manual).

- Determine suitable level of hardware sophistication, cost, reliability and maintainability.

- Establish pilot workload factors.

- Determine installation requirements.

- Estimate pilot training requirements.

- Recommend certification requirements.

- Define requirements for station signal quality monitor.

- Prepare and report guidelines for FAA implementation of OMEGA for use by helicopters.

• <u>For Global Positioning System (GPS) --- A Long Term Effort</u>

- Determine suitability of integral rotor antenna to receive satellite radiated signals.

- Conduct signal reliability tests and derive availability statistics.

- Develop and test coordinate conversion system to provide distance/bearing to waypoints.

- Determine rotor modulation effects with practical airborne antenna installations.

- Evaluate display and instrument alarm indicators:
  - Loss of station(s).
  - Recovery of station(s).
  - Hardware failure (automatic and manual).

- Determine suitability of hardware sophistication, cost, reliability and maintainability.

- Establish installation requirements.

- Establish pilot workload factors.

- Define TERPS with GPS.

- Estimate pilot training requirements.

- Recommend certification requirements.

- Define station signal quality monitor requirements.

- Prepare and report guidelines for FAA implementation of GPS for use by helicopters.

• *For Airborne Radar Approach (ARA).*

- Establish target detection capability and resolution.

- Define display luminosity.

- Evaluate display controls (weather *vs* ARA modes).

- Evaluate radar stabililzation requirements.

- Establish coverage requirements, i.e. distance (minimum and maximum) and angle for:
  - Weather mode.
  - ARA mode.

- Determine potential for beacon/ARA radar signal interference.

- Evaluate corner reflectors as target indicators.

- Evaluate Luneberg lens as target indicator and signal modulator for use as precision approach aid.

- Determine antenna and radome siting requirements.

- Evaluate display and instrument alarm indicators.
  - Rain cells.
  - Minimuum range (1800 ft.).

- Determine rotor modulation effects.
- Develop and recommend TERPS with ARA.
- Evaluate pilot workload factors.
- Determine installation requirements.
- Estimate operator/pilot training requirements.
- Recommend certification requirements.
- Evaluate beacon coding/performance.

• <u>For MLS</u>

- Determine suitable level of hardware sophistication, performance, cost, reliability and maintainability.
- Determine coverage requirements in azimuth, range, altitude.
- Evaluate interface with AFCS.
- Define minimum requirements for offset path computations.
- Determine requirements for platform stability and orientation.
- Determine potential for airborne radar interference.
- Determine antenna siting (ground and airborne) requirements.
- Evaluate display/instrumentation requirements.
- Evaluate cockpit workload factors.
- Determine airborne installation requirements.
- Determine potential for rotor interference.
- Develop and test integration with RNAV.
- Define data link requirements for helicopters.
- Prepare and report guidelines for implementation of MLS for use by helicopters.

2.2.6 Candidate Aids to Navigation

A brief description of the aids to navigation under consideration in the Helicopter Operations Development Plan follows.

The six currently operating radio navigation systems are:

- LORAN-A (not a candidate due to imminent phase-out)
- LORAN-C
- OMEGA/VLF
- VHF Omnidirectional Range (VOR) - Distance Measuring Equipment (DME)/Tactical Air Navigation (TACAN)
- Non-directional Radio Beacons (NDB)
- Instrument Landing System (ILS)

Additionally, two developmental systems are:

- Microwave Landing System (MLS)
- Navigation System Using Time and Ranging - Global Positioning System (NAVSTAR-GPS)

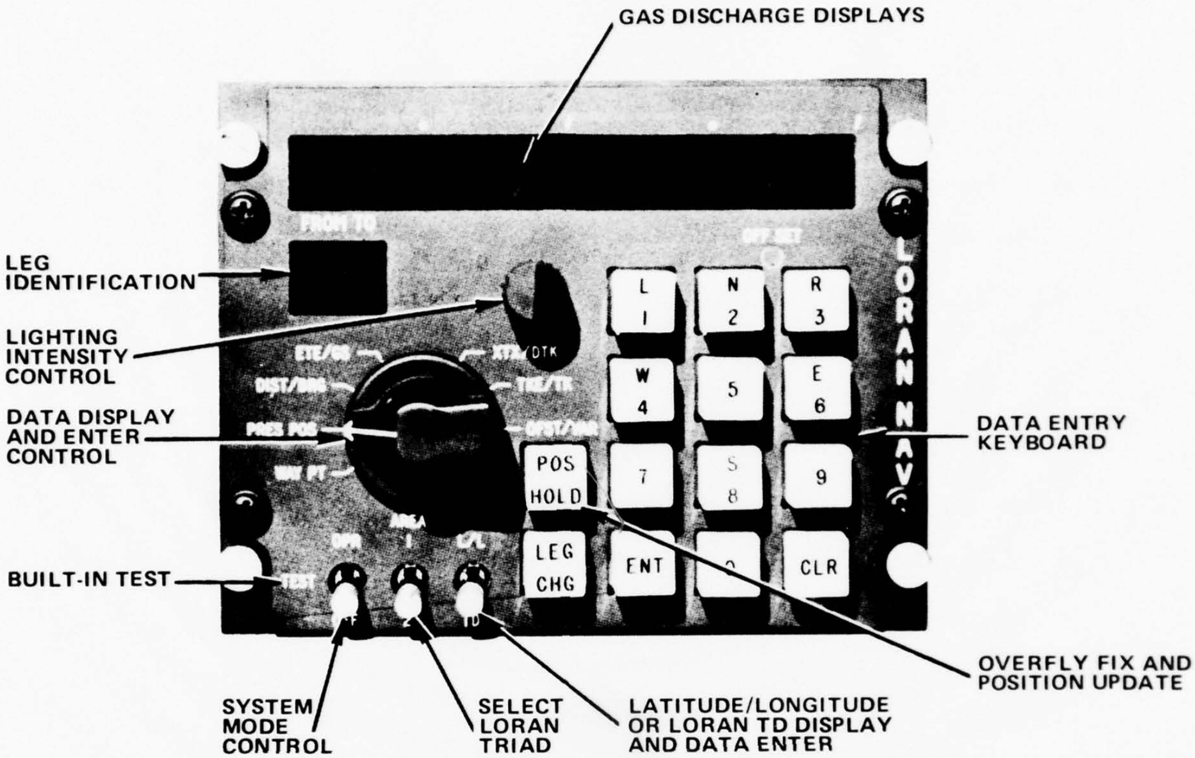
2.2.6.1 LORAN-A

LORAN-A was developed during WW II to provide a long range radio navigation capability. It was adopted by civil maritime users for navigation and position location and by civil intercontinental air carriers to bound the error of self-contained systems. LORAN-A is a pulsed hyperbolic radio navigation system operating in the 1800-2000 KHz band. The ground wave range is 600-800 NM over seawater and depends upon station power. The sky wave extends the range to 1500 NM. Predictable accuracy varies from 1-2 NM (2drms) using the ground wave, and 6-7 NM using the sky wave. The LORAN-A chains are being phased out with operations scheduled to end by mid-1980.

2.2.6.2 LORAN-C

LORAN-C was developed to provide DOD with a radio navigation capability having longer range and much greater accuracy than LORAN-A. It was subsequently selected as the U.S. provided radio-navigation system for civil marine use in the Coastal and Confluence Zone (CCZ). LORAN-C is a pulsed, hyperbolic system operating in the 90-110 KHz band. Ground wave range is typically 600-1400 NM over seawater. Predictable position accuracy is at least 0.25 NM (2drms) in defined ground wave coverage areas when using automatic receivers of current design. The repeatable accuracy is 50-300 feet. A typical LORAN-C display unit is presented in Figure 12.

When the LORAN-C system becomes fully operational in early 1980, its signals will cover not only the CCZ and other waterways but also two-thirds of the land area of the contiguous 48 states. It is anticipated



UNIT	SIZE	WEIGHT
ANTENNA COUPLER UNIT (ACU)	1.25H X 2.50W X 3.75D INCHES	0.5 LBS
CONTROL DISPLAY UNIT (CDU)	4.50H X 5.75W X 6.50D INCHES	4.5 LBS
RECEIVER COMPUTER UNIT (RCU)	7.52H X 7.50W X 12.58D INCHES	11.0 LBS

STANDARD ANTENNA IS AN
18" VHF TYPE WHIP WITH
COUPLER ELECTRONICS
POTTED IN BASE

Figure 12. Typical LORAN-C Equipment

that LORAN-C will be used increasingly to provide position information over land. To extend coverage to the entire 48 states will require three to five midcontinent stations. For near-term coverage see Figure 13. A joint program with the USCG has been established to evaluate the suitability of LORAN-C for use by helicopters on the experimental Northeast Corridor RNAV routes. Continued and expanded joint programs with the USCG will be carried out to evaluate the suitability of LORAN-C for use by helicopters in other areas. If studies indicate LORAN-C is an acceptable common system replacement for aviation, the following actions would be necessary.

- Insure adequate signal coverage.
- Obtain national/international agreement for its use.
- Change operating procedures establishing area navigation routes based upon use of the hyperbolic system.

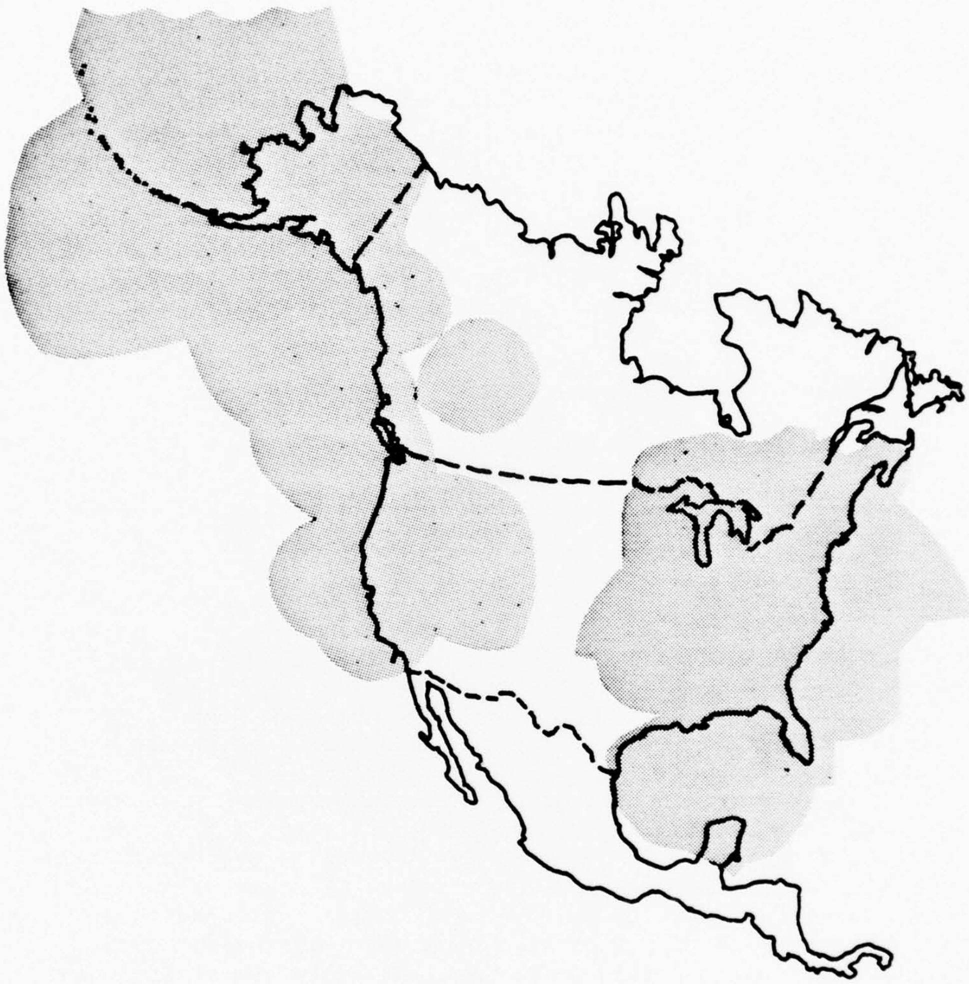
2.2.6.3 OMEGA/VLF

The OMEGA system has been developed and is being implemented by the Navy with Coast Guard assistance and the participation of several partner nations. Its purpose is to provide a world-wide position determination system and aid to navigation for civil and military air and marine users. OMEGA is a VLF (10-14 KHz), CW, phase comparison, circular or hyperbolic system. VLF propagation characteristics are such that eight transmitting stations can provide worldwide signal coverage. The design predictable accuracy of the system is 2-3 NM (2 drms) and depends on geographic location, station pairs used, propagation corrections, and time of day. The design repeatable accuracy is 1-2 NM (2 drms). Greater accuracies are possible through the use of fixed monitor stations to broadcast local corrections on a real-time continuous basis. The latter is an extension of the basic OMEGA system called "differential" OMEGA and exists only in alternative, experimental forms, and is in the developmental stage.

Seven of a planned eight permanent stations are presently transmitting and are located as shown in Figure 14. The eighth station is expected to be completed in late 1980.

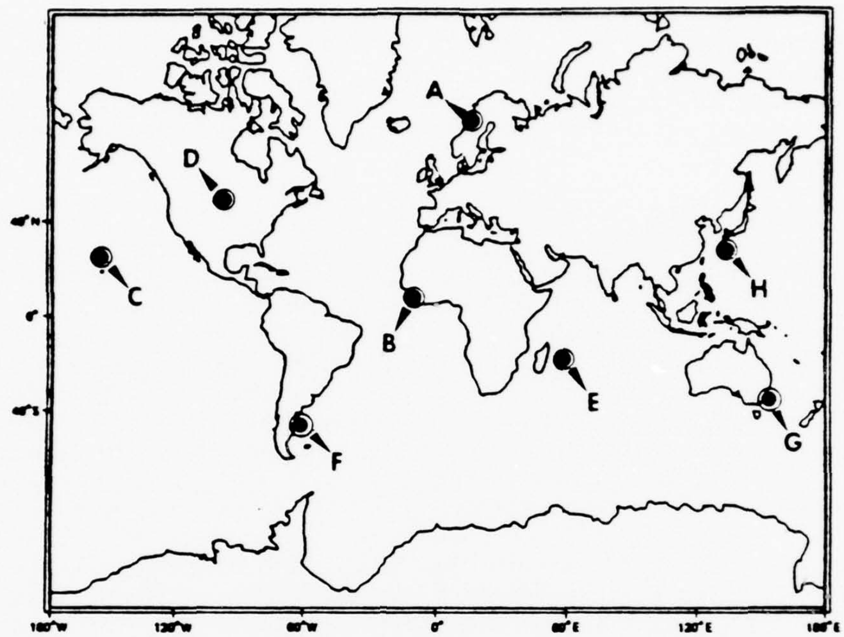
While system design accuracy is satisfactory for oceanic and high-seas navigation, it cannot meet the accuracy required for aircraft flying over land in some parts of U.S. Airspace. While ambiguity and limitations of signal lane width can be solved by using multiple frequency receivers, such receivers are more complex than single frequency receivers and costs are proportionately higher.

In addition to OMEGA transmissions in the VLF range, there are a number of Navy communications transmitters operating in the 14-30 KHz range. To accomplish their communications mission the VLF transmitters emit a phase



NOTE: CCZ, Coastal and Confluence Zone is defined as Harbor entrance to 50 NM offshore or the edge of the continental shelf (100 fathom curve) whichever is greater.

Figure 13. Near Term LORAN-C Coverage



LOCATION	PREFERRED STATIONS
Bermuda	A, C, D, F
Boston, MA	C, D, F, H
Eglin AFB, FL	C, D, F
Fairbanks, AK	A, C, D, H
Holloman AFB, NM	C, D, F, H
Seattle, WA	C, D, F, H

Key:
- A - Norway
- B - Liberia
- C - Hawaii
- D - North Dakota
- E - La Reunion
- F - Argentina
- G - Australia
- H - Japan

Figure 14. Omega Station Locations and Selection Chart.

stable, high power signal which can be used for VLF navigation. Each transmitter uses a carrier frequency unique to that station. By using multiple fixed tuned receivers, a common intermediate frequency for phase measurement and an appropriate computer, navigational position can be determined. This method is also subject to the lane ambiguity problems associated with OMEGA.

2.2.6.4 VOR-DME/TACAN

The VHF Omnidirectional Range (VOR), Distance Measuring Equipment (DME) and Tactical Aid to Navigation (TACAN) systems provide basic guidance for enroute air navigation in the U.S. VOR provides an aircraft azimuth information relative to the VOR ground station. DME provides a measurement of distance from the aircraft to the DME ground station. In most cases VOR and DME are collocated as a VOR-DME facility. TACAN provides both azimuth and distance information and is used primarily by military aircraft. When TACAN and VOR are collocated it is a VORTAC facility. DME and the distance measuring function of TACAN are the same.

VOR operates in the VHF (112-118 MHz) band. The overall system, including avionics has an accuracy of ± 4.5 degrees (95%). DME operates in the UHF (960-1215 MHz) band and provides distance information with an accuracy of ± 0.5 NM or 3% of slant range (whichever is greater) (95%). TACAN also operates in the UHF band (960-1215 MHz) providing azimuth and distance information to the same accuracy as VOR-DME.

The VOR-DME/TACAN system meets the current needs of most civil users of the domestic enroute air navigation system. Area navigation (RNAV) route structures are presently based on use of the VOR-DME system.

VOR-DME/TACAN signals are relatively undisturbed by atmospheric or man-made noise. VOR transmissions are vulnerable to multipath propagation and some unique site related problems and are somewhat restricted in utility and accuracy. Use of Doppler VOR systems greatly alleviates the multipath problem. Inasmuch as these systems use VHF/UHF signals, they are restricted to line-of-sight applications. This greatly reduces their usefulness in mountainous terrain, and seriously limits coverage at the low altitudes normally utilized by helicopters.

2.2.6.5 Radiobeacons

Nondirectional beacons (NDB) are used for transition from enroute to precision approach facilities and as a non-precision approach aid at many smaller airports. They provide the radio aid to navigation for short over water segments of flights which may be beyond the range of VOR. In Alaska they are an integral part of the low altitude airways structure.

The beacons also relay transcribed weather broadcasts. Marine radiobeacons provide a backup to more sophisticated radio-navigation systems and provide the primary service to many small vessels equipped with

minimal radio-navigation systems. Beacons transmit in bands between 200-415 KHz over ranges from 10 to 350 NM depending on location, operational objective and power. Bearing accuracy is of the order of $\pm$ 3 degrees. While this system does not allow for precision navigation, it has wide user acceptance and is used when there are no known alternative systems which would be as cost effective for the user and the government.

2.2.6.6 Instrument Landing System (ILS)

The FAA presently operates 528 full ILS facilities. The Instrument Landing System provides aircraft with vertical and horizontal navigation (guidance) information during the approach to landing. ILS ground equipment consists of a localizer facility, a glide slope facility and two or three marker beacons. The localizer provides horizontal guidance about the extended runway centerline with an accuracy of $\pm$3 degrees from at least 18 NM to touchdown and transmits in the 108-112 MHz band. The glide slope facility provides vertical guidance to an approaching aircraft. The glide path angle is nominally 3 degrees above the horizontal. The glide slope transmits in the 328-335 MHz band. Marker beacons indicate discrete distance to runway threshold and transmit at 75 MHz. Most ILS provide for Category I approaches (DH-200 feet, RVR-1800 feet). Some systems have been improved to provide Category III A (DH-not prescribed, RVR-700 feet) landings.

While ILS is the accepted civil standard in the U.S. and internationally, it does have limitations. Terrain considerations are a factor in ILS installation. Special account must be taken of signal reflections (multipath) from taxiing aircraft and other surface traffic obstacles. The single approach path provided by ILS constrains airport capacity and noise control. In regions where many airport runways require ILS, the saturation of available radio frequency channels can become a limiting factor. Lastly, ILS does not meet all military system requirements.

2.2.6.7 Microwave Landing System (MLS)

The Microwave Landing System is a joint development of the DOT, DOD and NASA under FAA management. Its purpose is to provide a civil/ military, Federal/non-Federal standardized approach and landing system with improved performance and more flexible implementation. MLS has been adopted by ICAO as a future international standard and is planned to supercede ILS.

Approach and landing navigation information is aircraft derived, based on ground transmitted signals. Angle signals, at 5030-5090 MHz, combined with a Precision Distance Measuring Equipment capability, provide data over a wide volume of airspace, up to $\pm$60 degrees from runway centerline, 1 to 15 degrees elevation, and out to 20 NM range (see Figure 15). The system employs the Time Reference Scanning Beam technique (TRSB) and the

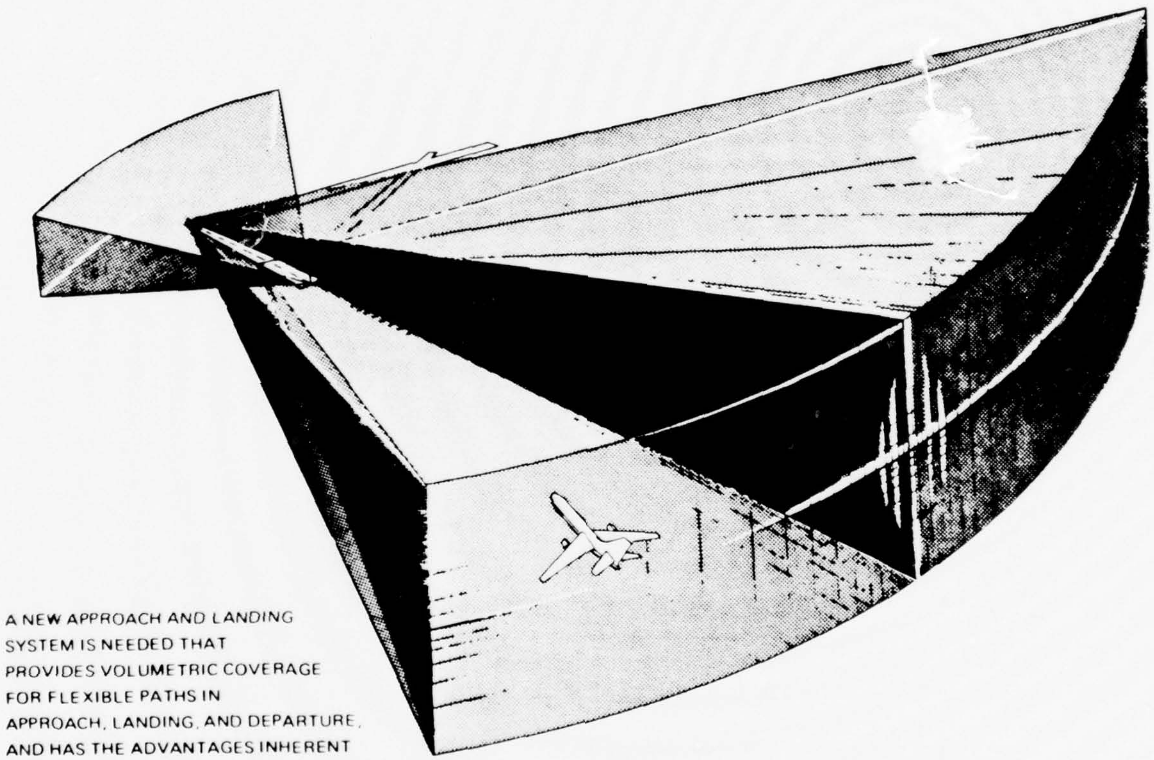


Figure 15. MICROWAVE LANDING SYSTEM (MLS)

signal format lends itself to a variety of implementation forms ranging from simple and inexpensive to complex. The more complex systems enable landing under zero visibility conditions and provide wide azimuth coverage.

2.2.6.8 NAVSTAR Global Positioning System

NAVigation System using Time And Ranging - Global Positioning System (NAVSTAR-GPS) is a radio navigation system concept under development by DOD. It will use satellites to provide worldwide, continuous, real-time, all-weather, precision positioning information to users operating equipment in a passive mode. Initially DOD plans to deploy 6 satellites which are to be used to validate the system concept. By the mid-1980's, 24 satellites are to be deployed with 8 satellites in each of three 63 degree inclined plane circular orbits at 11,000 NM altitude. Each satellite will broadcast very precise time and the locations of every satellite on 1227 and 1575 MHz frequencies. A worldwide monitor network will report to a U.S. based master station which will in turn compute changes to satellite locations and time reporting. Users equipment will be of varying sophistication with the most sophisticated expected to provide predictable accuracy of 50-100 feet (2 drms) in three dimensions. Less accurate positioning (300-600 feet) can be provided at lower cost. The system is so designed that the use of the higher accuracy capability can be restricted to select users with the lower accuracy capability available to all.

It is expected that the NAVSTAR-GPS concept validation phase will be completed in 1979. Based upon the DOD decision made at this time, the system could become fully operational by 1986.

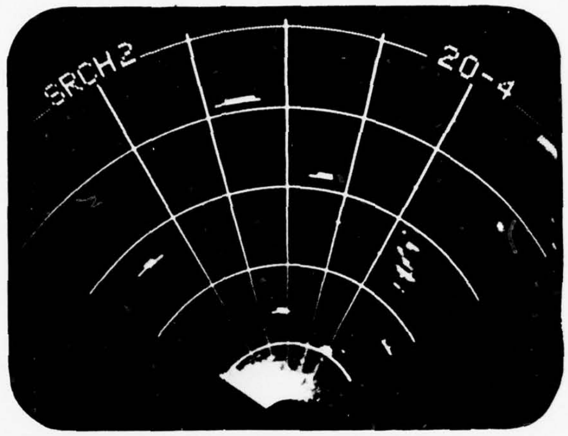
2.2.6.9 Airborne Radar Systems

Airborne radar systems have been installed in aircraft since World War II. Recently, light weight, digital X-band (9000-9500 MHz) radar systems have been installed in rotary wing aircraft. These radars can be operated in weather-avoidance, air-to-surface search and transponder beacon modes. They have been utilized in patrol, search and rescue missions, and transportation of personnel and equipment to remote sites (off-shore oil rigs, etc.).

Airborne radars are currently being used in helicopters as a supplementary Navigation Aid to identify off-shore landing sites, for guidance during non-precision approaches to off-shore helipads and easily recognizable sites on a coastline, for determining range to recognizable landmarks, and for assurance of obstacle clearance during letdowns at sea. Minimum operational performance standards for airborne radar equipment used in these modes are being developed by RTCA, and criteria for approving their use are being developed by FAA Flight Standards Service; however, additional test data on their performance, capabilities, and limitations are needed.

Figure 16 is a radar scope presentation typical of that seen during approach to an off-shore oil rig.

Offshore Surface Targets



Transponder Beacon Return

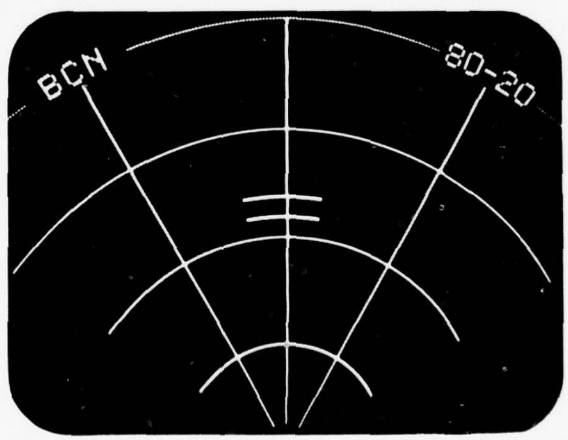


Figure 16. TYPICAL AIRBORNE RADAR PRESENTATIONS

2.2.6.10 Radar Transponder Beacons (RACON)

Radar transponder beacons are designed for use in conjunction with navigational radars. Typically the transponder transmits a pulsed reply for each received radar interrogation. The reply may be coded to provide positive identification of the transponder site. X-Band (9000-9500 Mhz) transponders are set in typical beacon mode of 9375 MHz receive and 9310 MHz transmit. Beacons are normally sited on off-shore drilling rigs, buoy moorings, seamark and landmark locations. The Coast Guard presently operates approximately 30 RACONS - this number is expected to gradually increase. Figure 17 shows a typical Radar Transponder Beacon. They have the potential for improving airborne radar approach operations by enhancing identification of specific landing sites, which may not otherwise be distinguishable from the surrounding area.

2.2.6.11 Radar Reflectors. Corner reflectors and Luneberg lenses have been employed in special ground configurations to provide identifiable targets for airborne radar. Used in this manner they may have potential for enhancing the utility of airborne radar as an approach aid. In addition, special designs of Luneberg lenses have the potential for adding a modulation to the reflected signals so that the airborne radar can be used to derive precise deviation angles from a defined approach path. The suitability of using these devices to enhance airborne radar approaches has not been clearly established.

2.2.7 Major Decision Points

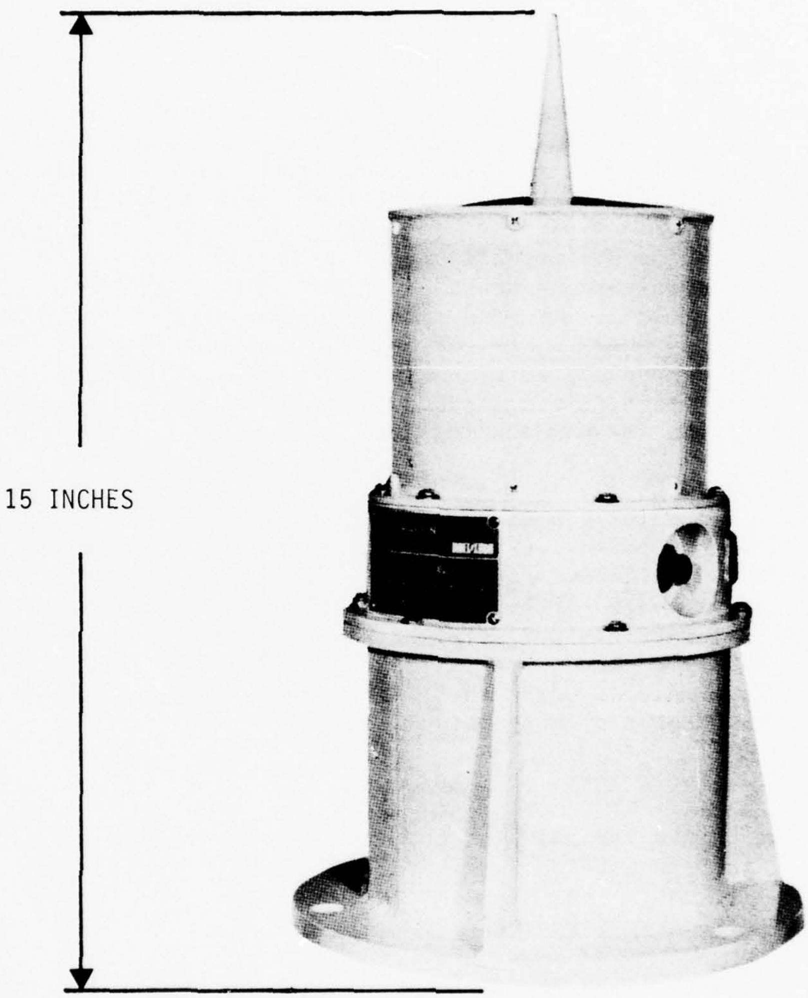
Major decision points for the near term navigation program are outlined in Figure 7, found in Section 1.

2.2.8. Program Management/Schedule

Program Management will be as set forth in Section 4. The Helicopter Navigation System Development Program Schedule is depicted in Figure 18.

2.2.9 Funding Requirements

Helicopter Navigation System Development Funding Requirements are included in the Helicopter IFR Operations Program (Section 2.1.5).



WEIGHT: 9 POUNDS

Figure 17. Typical Radar Transponder Beacon

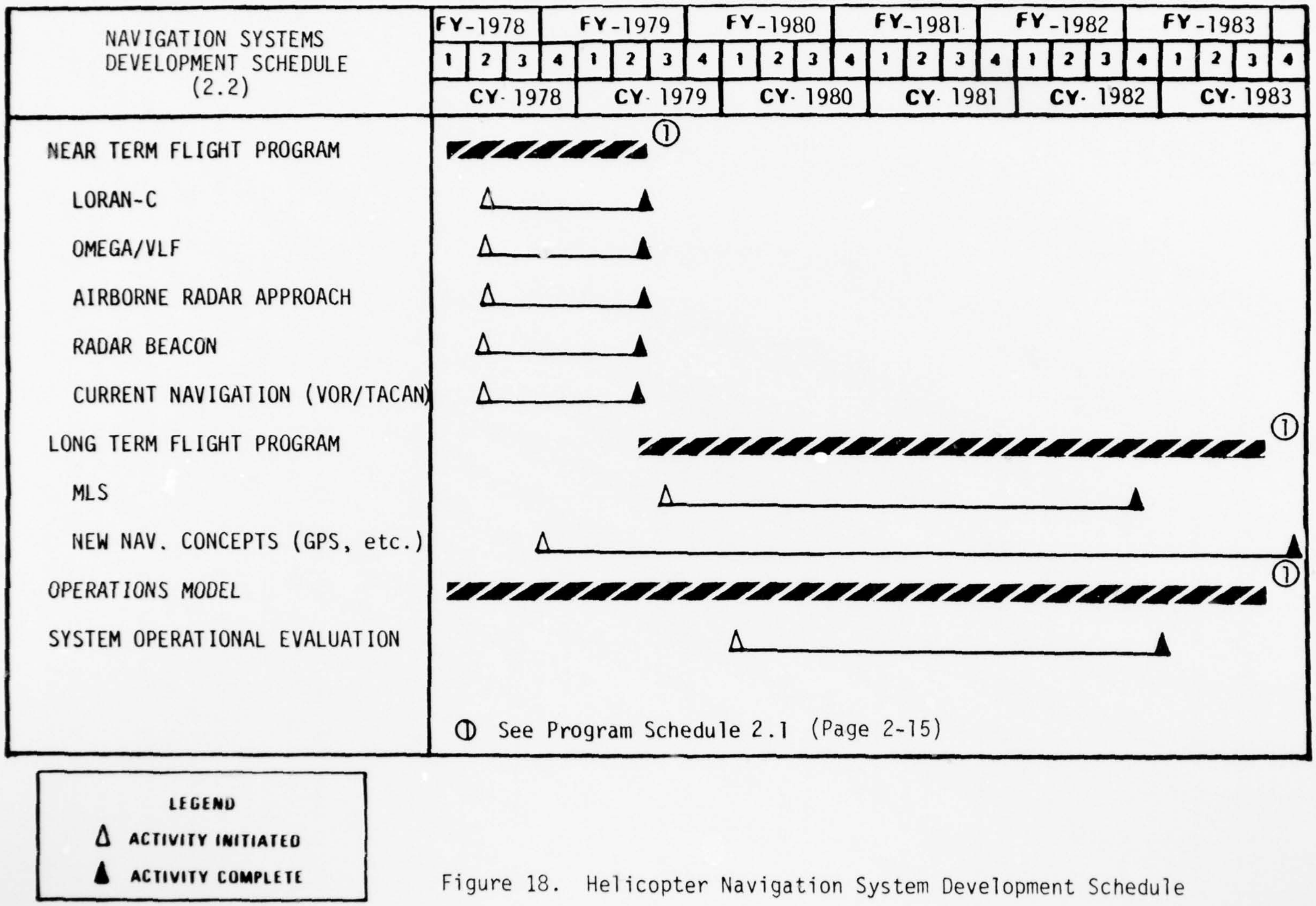


Figure 18. Helicopter Navigation System Development Schedule

2.3 Helicopter Communication System Development

Communications must be maintained with controlled aircraft under current ATC procedures. Should an aircraft conduct flight along an approved route which is known to be beyond communications range, ATC procedures change from those for normal operations. When communications are not maintained, the ATC controller assumes that the controlled aircraft can navigate no better than normally achieved by dead-reckoning (DR). This causes an assumed navigation error to buildup as a function of the time out of communications range. The assumed (DR) navigation error causes the ATC controller to provide large spacing between aircraft to assure enroute flight safety.

Using the above procedures, two aircraft may be equipped with the best navigation systems available, yet they can not be dispatched with normal ATC spacing because the crews are unable to communicate their position to the ATC controller. Spacing defines the maximum number of aircraft which can be dispatched to and from an offshore oil rig complex. The current procedures are utilizing very conservative spacing practices to insure operational safety.

2.3.1 Objective

The objective of the Helicopter Communication System effort is the development and evaluation of communication systems for low-flying aircraft within the NAS.

- The short term objective is to determine the requirements needed to establish ATC communications systems and facilities in support of helicopter operations as far as 300 miles off-shore in the Atlantic coastal region.

- The long term objective is to develop an ATC communications system which will support safe and optimum operation of helicopters flying at low altitudes anywhere within the NAS.

2.3.2 Important Considerations

The present ATC communications system has been developed primarily for inland U.S. operations with the assumption that a communication facility or outlet would be available at flight termination points. Moreover, current ATC operational procedures are more suitable for fixed-wing aircraft which are usually flown higher and faster than helicopters. The trend of ATC communication to use the VHF (and UHF for the military aircraft) band has not been a problem. In fact, the "Line of Sight" (LOS) communications limitation of VHF and UHF has been used to an advantage as it allows the reuse of a given frequency when sufficient geographical separation is used. There has not been adequate frequency spectrum space available in the present HF, VHF and UHF bands for enough channels to conduct ATC operations properly without taking advantage of the LOS limitation.

As more and more helicopters fly using their unique capability to operate low and slow, their LOS range from the nearest communications facility becomes less and less i.e., if the ground communications antenna and the helicopter are both at 100 feet, the LOS communications range is 30 miles, and if the helicopter climbs to 1,000 feet, he only extends his LOS range to 65 miles. With the helicopter operators stating requirements for ATC communications when they are on an east coast oil drilling platform, 50 feet above the sea level and 50 to about 300 miles offshore, the present standard ATC communications system does not meet the requirement.

2.3.3 Critical Issues

The critical issues of the Helicopter Communications System Development program that need to be addressed are:

- Should the present VHF and UHF ATC communication system with its LOS limitation be extended by "brute force" to cover the proposed helicopter operating areas or, should a new technique (by comparison to today's ATC communications system) such as HF, VLF, satellite, etc., be implemented and overlaid onto, and made a part of, the present ATC communications system?

- Should the furnishing of ATC communications service to the offshore helicopters be implemented on a piecemeal basis (on demand, geographically), or should a planned step increase in the ATC communication service area be initiated?

2.3.4 Major Tasks

The effort will consist of four major tasks:

- Task A - Study Requirements. Study and correlate technical and operational requirements for a new communication system capable of providing adequate air-to-ground and ground-to-air information transfer beyond present radio line of sight from the present Air Traffic Control communication facilities and also extending about 300 nautical miles from the coastline. Performance characteristics related to channel loading and access, propogation anomalies, pilot-controller workload, reliability and availability, and new techniques and equipment will be examined to establish design criteria. Information pertinent to the selection decisions and design evolution alternatives will be developed.

- Task B - Specify Major Characteristics. Specify recommended offshore communications system technical design and techniques. Describe major characteristics and specify ground and airborne equipments. The proposed system will emphasize use of conventional equipment except where new ATC techniques are used that require development. Sufficient equipment specification detail, functions, and description will be provided to enable procurement and development of components.

- Task C - Procure and Develop Equipment. Develop and procure equipment specified and modify as required to provide for and accommodate total systems requirements. The items considered are those airborne and ground terminal equipments required for use in verification and demonstration testing.

- Task D - Evaluate Operational System. Demonstrate, evaluate, and verify total systems compatibility to perform the communications task, and define design and implementation criteria for this and similar applications.

2.3.5 Program Technical Approach

The technical approach to the helicopter communications program contains two major divisions of emphasis. The first is the near term effort and the second is the long term effort.

The near term effort will consist of evaluating communications for helicopter low level operations extending about 300 miles offshore. The near term effort has two phases.

Phase 1 - Calibration of extent of ATC communication coverage at NAFEC using present ATC communication equipment.

Phase 2 - Modification of present equipment using improved high gain directional antennas and then measuring the amount of the improvement in communications coverage.

The long term program will define, verify, and establish communication systems design and implementation criteria in support of offshore oil and remote/mountainous terrain/low level overland operations using helicopters.

Major subjects to be addressed in the Helicopter Communications System Development program are:

- Can existing technologies (and the present ATC communications system) be utilized to meet the requirements of the low level offshore helicopter operations?

- Are equipment and/or techniques available that could be utilized to meet the requirements of the low level offshore helicopter operations?

- Decision needed on which technique to utilize.

- Decision on method of implementing the new system and how to integrate it into the existing ATC communication system.

2.3.6 Program Management and Interface

The overall management of the Helicopter Operations Development Plan is under the Approach Landing Division, ARD-700. It is being currently organized and managed by the Helicopter Program Staff, ARD-706. The communications aspect of the Helicopter Program will be initially organized and formulated at the staff level and then specific tasks will be levied on the Communication Branch, ARD-220, of the Communication Division, ARD-200, for Development, Test and Evaluation. Other participants in the communications area will be NAFEC and Industry (Helicopter and Electronic). See Figure 19 for Program Schedule.

2.3.7 Funding Requirements

Helicopter Communications System Development Funding Requirements (FY,$000):

	1979	1980	1981	1982
TOTAL	100	100	100	100

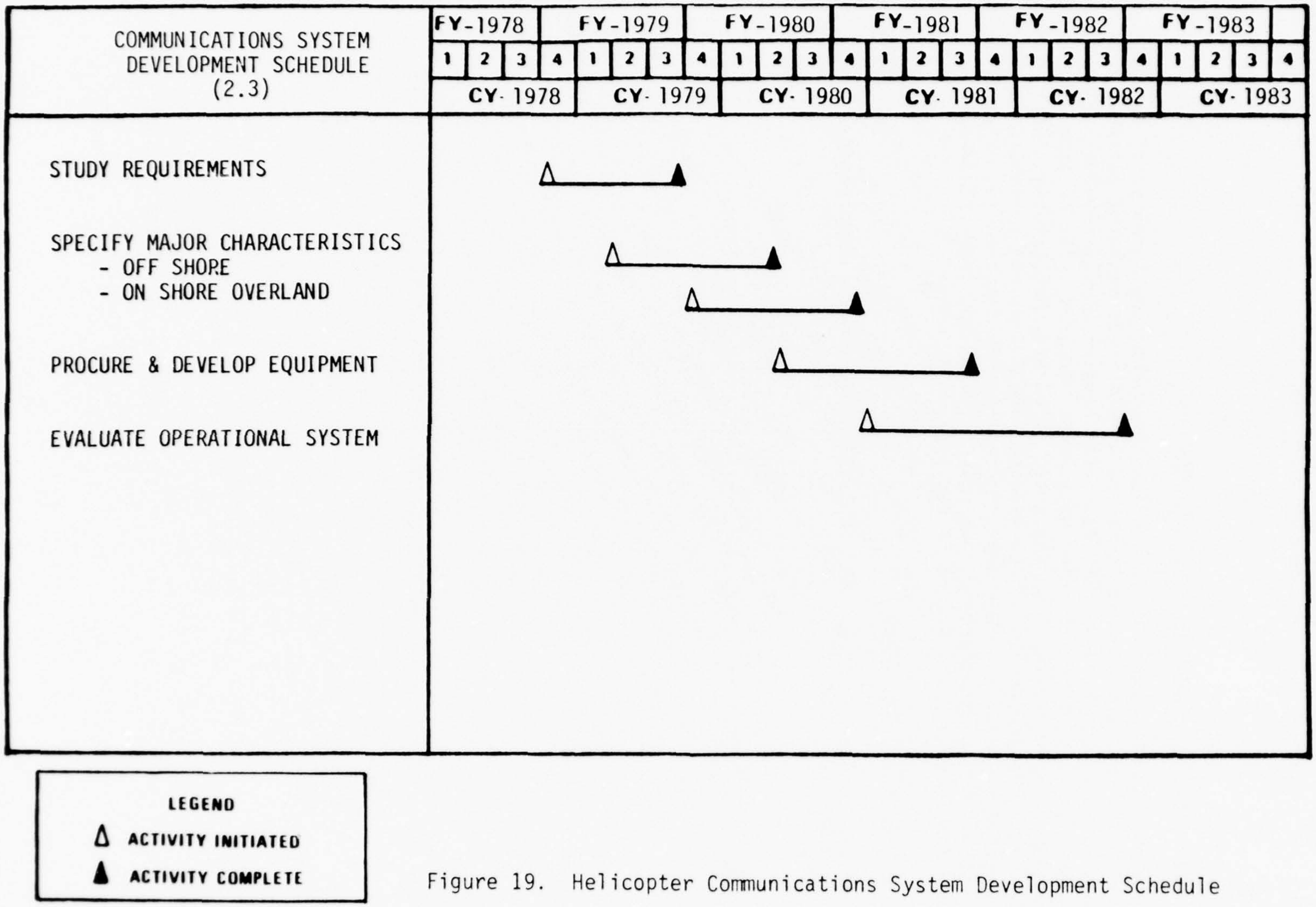


Figure 19. Helicopter Communications System Development Schedule

2.4 Helicopter Air Traffic Control Program

As IFR helicopter activity has started to grow in the past few years, individual requests for new helicopter procedures at specified locations have been received and acted upon by FAA headquarters and regional offices. In addition, an extensive FAA effort was made to lay out and start gaining experience with experimental RNAV helicopter routes in the Northeast Corridor of the United States. Programs are ongoing to evaluate the use of LORAN-C, OMEGA/VLF, and VOR/DME RNAV systems on these routes. The helicopter ATC development activities described in this plan will be designed to build upon and add to this base of experience, and will take advantage of other development programs which are applicable to all classes of aircraft.

Given the many projections of increased helicopter activity throughout the United States in the near future, Air Traffic Control activities throughout the National Airspace System need to be prepared for the addition of significantly increased helicopter flight operations. These additional new helicopter operations will probably impact most rapidly in the Northeast Air Corridor where significant overland flight activity as well as new traffic generated by the off-shore drilling sites are projected. It appears that these new operations will be conducted within the NAS (and especially in the Northeast) in "controlled" as well as "uncontrolled" airspace (See Figure 20) at altitudes generally below 10,000 feet, and frequently at very low cruise altitudes close to the surface in VFR, special VFR and IFR conditions. Since Air Traffic Control activities rely on the total grouping or embodiment of many facilities and entities; such as, communications equipment and procedures, navigational systems and techniques, flight controller-aircraft pilot interaction, designated national airspace, routes, terminals, aircraft, weather, operational procedures, rules, regulations and many other related facilities, services and capabilities; the ATC system represents one of the most closely involved FAA activities directly pertaining to the successful, economical and safe integration of the helicopter into the National Airspace System. The ability of the ATC system to adjust and innovate in order to integrate the helicopter into all aspects of flight operations in the Northeast Corridor, while accommodating its unique and special flight capabilities and minimizing those procedures that will inhibit or compromise its economic and operational success, will be a most challenging task for ATC. Typical helicopter operations will include route structures and flight situations such as city center-to-city center, congested area-to-remote site, remote site-to-remote site, and remote site-to-major airports that are to be utilized essentially on an all-weather basis.

2.4.1 Objective

The objective of the Helicopter Air Traffic Control effort is to establish safe, economical and technically feasible procedures, practices and operational concepts that will enhance the orderly implementation of increased helicopter activities in the National Airspace System. In

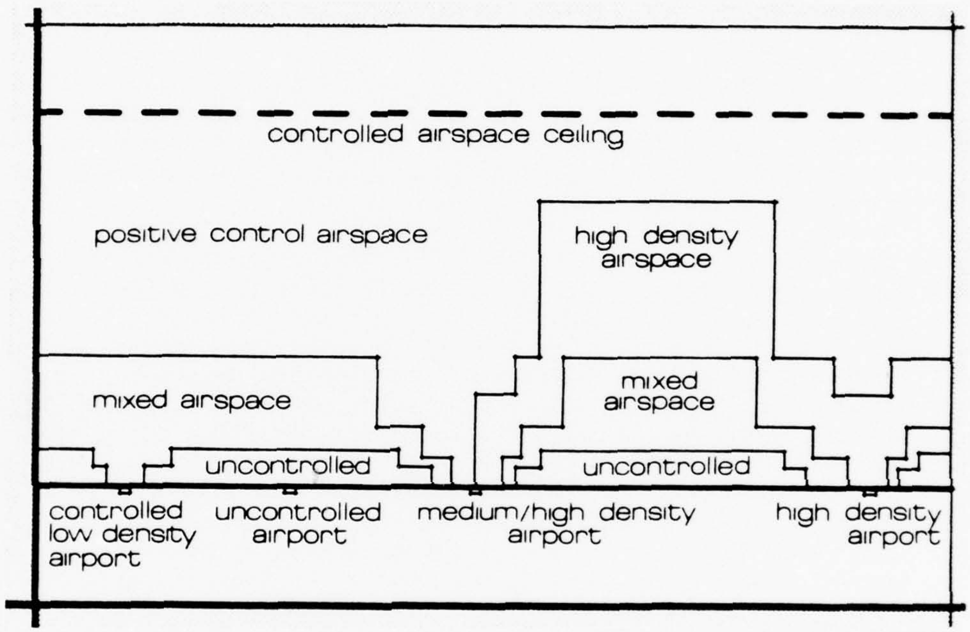


Figure 20

Model illustrating different airspace classifications used in today's ATC System. (Reference: Gilbert & Associates, Inc.)

addition to developing enhanced procedures in specific areas, the effort will seek to develop common guidelines and criteria for the establishment of efficient procedures and practices for integrating IFR helicopter operations with other traffic, anywhere in the NAS. The effort will attempt to recognize and accommodate all the flight characteristics peculiar to helicopters, their unique capabilities and flexibilities as well as their limitations, so that they may be properly integrated into the system in a way that maximizes their ability to meet the national transportation needs they are expected to provide.

- The near term objectives of the program will be to support the prompt implementation of procedures and practices that will provide for safe, economical and efficient ATC enroute and terminal helicopter operations within the National Airspace System. This will include initiation of internal review/modification and solicitation of external comments/suggestions on subject matter pertinent to updating and amending ATC rules, operations and procedures (especially time-critical changes) as set forth or contained in the applicable government documents --- especially Chapter 11 (Helicopter Procedures) of the U.S. Standard for Terminal Instrument Procedures (TERPS) and the Airman's Information Manual (AIM).

- The long term objectives of the program will include:

  - The fullest exploitation of the entire upgraded third generation ATC system and all its related components and new equipment for the maximum and optimum utilization available for helicopters.

  - Development of separate and permanent route structures and procedures, within the common ATC system, that enhance the operation of different types of aircraft and especially provide, where possible, a non-interference pattern between airplane and helicopter operations.

  - Completion of current FAA/NASA cooperative programs and appropriate utilization of acquired data and results on investigations related to fuel-optimized arrival and departure procedures, 4-D navigation concepts, cockpit display of traffic information and other continuing programs where applicable.

  - Development and continued updating needed for the appropriate ATC interface required for the new helicopter operations in the Atlantic off-shore area. Continued review is required because of the significant weather patterns encountered in the area and the special circumstances dictated by the high density of air traffic and large amounts of "controlled-airspace" along the Atlantic coastal areas of the NAS. Provide recommended means for accommodating the impending increase in IFR helicopter operations in high-density traffic areas of the Northeast Corridor.

2.4.2 Important Considerations

The FAA has the responsibility for insuring the safe and efficient use of the National Airspace System , for all users, for fostering air commerce and aeronautics and for supporting the requirements of national defense. One of the most vital aspects of promoting this responsibility for all aviation (including helicopters) is the continued updating of the Air Traffic Control System and all its supportive services, equipments, and procedures. Significant innovations, additions and changes are occurring continuously in what is now known as the "upgraded, third-generation, Air Traffic Control System". Although a full listing of all programs and equipments (being developed or already operational) is long, some of the major features and programs of the current "upgraded" ATC system are:

- ATARS - Automated Traffic Advisory and Resolution Service; will provide advisories to identify the kind of maneuvers that will best solve a traffic "conflict" (requires DABS implementation).

- DABS - Discrete Address Beacon System; (with the data link) will provide a fundamental advancement in all aspects of beacon use and Air Traffic Control and communication.

- Upgraded FSS - Upgraded Flight Service System - upgraded with increased automation.

- Upgraded ATC automation - Upgraded ATC installation - upgraded with increased automation to enhance the metering and spacing function.

- Airport Surface Traffic Control

- Wake Vortices Measurement

- RNAV - Area Navigation

- MLS - Microwave Landing System

- Satellite use for Aviation

Increased helicopter flight activities (especially the important circumstances of off-shore operations, high density traffic, large controlled airspaces, northeast coastal weather etc.) represent an immense field of new initiatives in research and development as related to Air Traffic Control services, programs, equipment, procedures and operations. Recognizing that it frequently takes over 10 years to carry a program from an "R&D concept" to "implementation" to "fully operational", a heavy burden rests on any decision-making individual or process that develops, purchases and integrates new equipment into the system in response to a "requirement". Continued review of current programs must be made in order to insure that decisions are based on valid requirements and that the varied interests of the <u>entire user</u> fleet are adequately represented.

A small segment of users, the helicopter community, currently is operating in an airplane-dominated environment. If near term projections on growth and activity are correct, this situation may be altered somewhat in select areas of the NAS. Given the short haul nature of some commercial helicopter operations, it may be possible that larger numbers of localized short flights, landings and take-offs will be made per given time period than is typical for airliners or executive airplanes in certain locales. Whether the current upgraded ATC system will be able to respond properly (and in a timely fashion), should a "sudden" demand occur, needs to be carefully examined.

2.4.3 Issues

- Based upon the navigation and communications systems selected, what ATC procedure changes must be developed to eliminate any unnecessary spacing constraints and allow MDAs of 200 feet and MEAs of 500 feet above obstacles?

- Should the NAS accept full and sole responsibility for low-altitude, far off-shore remote area, helicopter operations or should "distributed management" techniques be considered and implemented?

2.4.4 Major Tasks

- Task A - Develop Pilot/Controller Workload Criteria. Develop pilot/controller workload criteria related to performing each required phase of the various operations concepts (see B through E below).

- Task B - Develop Offshore Concepts. Develop operational concepts for single and multiple helicopter IFR arrivals and departures to offshore oil rigs and/or clusters of rigs.

- Task C - Develop City Center-to-City Center Concepts. Develop new operational concepts for operation of helicopters to proceed from city center-to-city center direct with the most optimized procedures consistent with the inherent flexibility of the large, higher performance, high speed helicopters during all-weather conditions.

- Task D - Develop Major Airports Concepts. Develop operational concepts for maximized IFR helicopter arrivals and departures to and from major airports and multiple downtown heliports, with independent paths where possible and/or predetermined non-conflicting, flow-through routes in relation to conventional aircraft.

- Task E - Develop Low Level/Overland/Remote Area Concepts. Provide criteria similar to C and D.

- Task F -Simulation. Simulate most promising concepts to minimize cost and time for development.

- Task G - Forward Implementation Data. Validated concepts and procedures forwarded to operating services.

2.4.5 FAA/NASA Cooperative Programs

The FAA project summaries detailed below outline the joint program activities with NASA Ames Research Center in: Fuel-optimized Arrival and Departure Procedures, 4-D Navigation Concepts, STOL and VTOL Operations and Feasibility of Cockpit Display of Traffic Information (CDTI):

- FAA/NASA Simulations. Reports will be provided by NASA and NAFEC on the AVP-200 9550 project and on other studies by continuing to support Joint Studies of STOL, 4-D Nav., and Fuel Optimized Approaches by September 1979. Operational scenarios will be provided using high performance flight simulators at NASA-Ames to evaluate advanced 4-D electronics systems, for live tests of STOL aircraft and in design, test, and evaluation of fuel optimized flight procedures. Scenarios will be provided for traffic models, test design for STOL simulations at Ames and for live tests at Crows Landing (an experimental airport). Operational support will be provided to Ames for mini-simulations conducted at Ames. Scenarios and test design for those experiments will be provided where the Ames Flight Simulators are fitted into the NAFEC ATC Simulation Facility. Dependent on the size of the experiment or which agency is in a support role, the cooperative program calls for some experiments at Ames and others at NAFEC.

- FAA/NASA VTOL/Helicopter Support Program. In support of NASA short haul helicopter operations, operational support will be provided in near-term Northeast Corridor CH-53 helicopter activities; current oil rig operations; future designs for IFR oil rig operations; VTOL operations city center-to-city center; major airport-to-city center; and all areas in a large metropolitan locale.

- FAA/NASA - Cockpit Display of Traffic Information (CDTI). (To investigate the concept of distributed management). This subprogram is in response to proposals for distributed management concepts between ground systems and airborne participants. Concepts will be formulated, simulated and evaluated against a 1985 type ATC scenario in assurance/confidence, pilot monitoring modes, and pilot cooperative modes such as lock-on and merging traffic assistance. Program development and operation is a cooperative effort between OSEM, SRDS, and NAFEC and in conjuction with NASA-Ames and Langley Research Centers.

When using an in-house mini-simulation capability at Ames, FAA provides ATC scenarios and controllers for experiments. When larger experiments are tried, the Ames Simulators (that are piloted by Airline, NASA and FAA pilots) are tied to the ATC Simulator at FAA's Experimental Center at Atlantic City, N.J. (NAFEC), for full system testing. The unique capability to link the facilities at NAFEC with those at NASA-Langley and Ames, in a real time simulation of the enroute and terminal environment, will be applied in the development of the most promising concepts as determined from the programs above. (See Figure 21). Final validation of the concepts would be accomplished in actual flight testing using the proposed FAA acquired helicopter.

2.4.6 Program Management and Interagency Participation

The Helicopter Air Traffic Control Program will be managed by the Helicopter Program Staff (ARD-706) and specific requirements, tasks and directions will be under the control of the Operational Requirements Branch, ARD-150. (See Figure 22 for Schedule).

Extensive cooperation and interaction will be accomplished with NASA, the military services and the United States Coast Guard. Major joint programs currently being conducted by NASA and the FAA will demand continued close monitoring and coordination regarding progress, data acquired and analyzed, determination of objectives and updating of requirements.

2.4.7 Funding Requirements

Helicopter ATC Funding Requirements (FY $000):

	1978	1979	1980	1981
Total	100	200	300	100

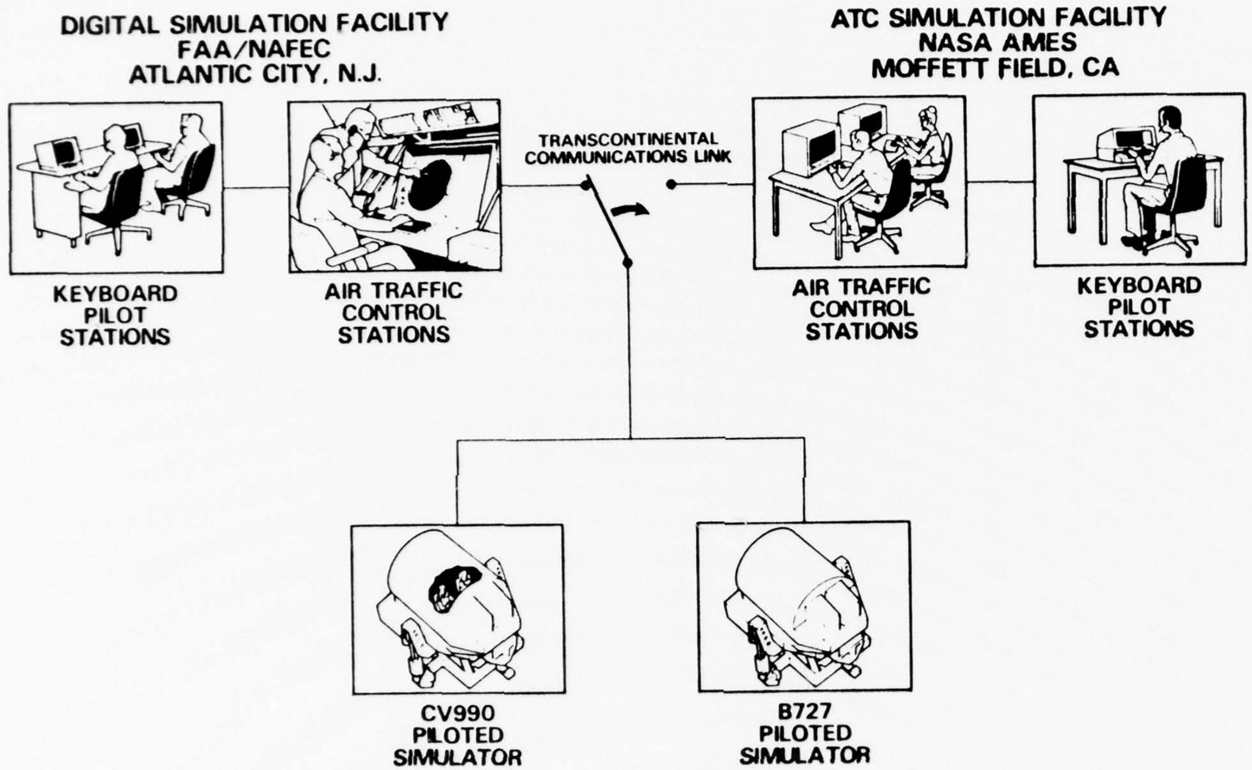


Figure 21

Joint FAA-NAFEC/NASA Ames
SIMULATION FACILITY
(Ref: SAE Paper 780523)

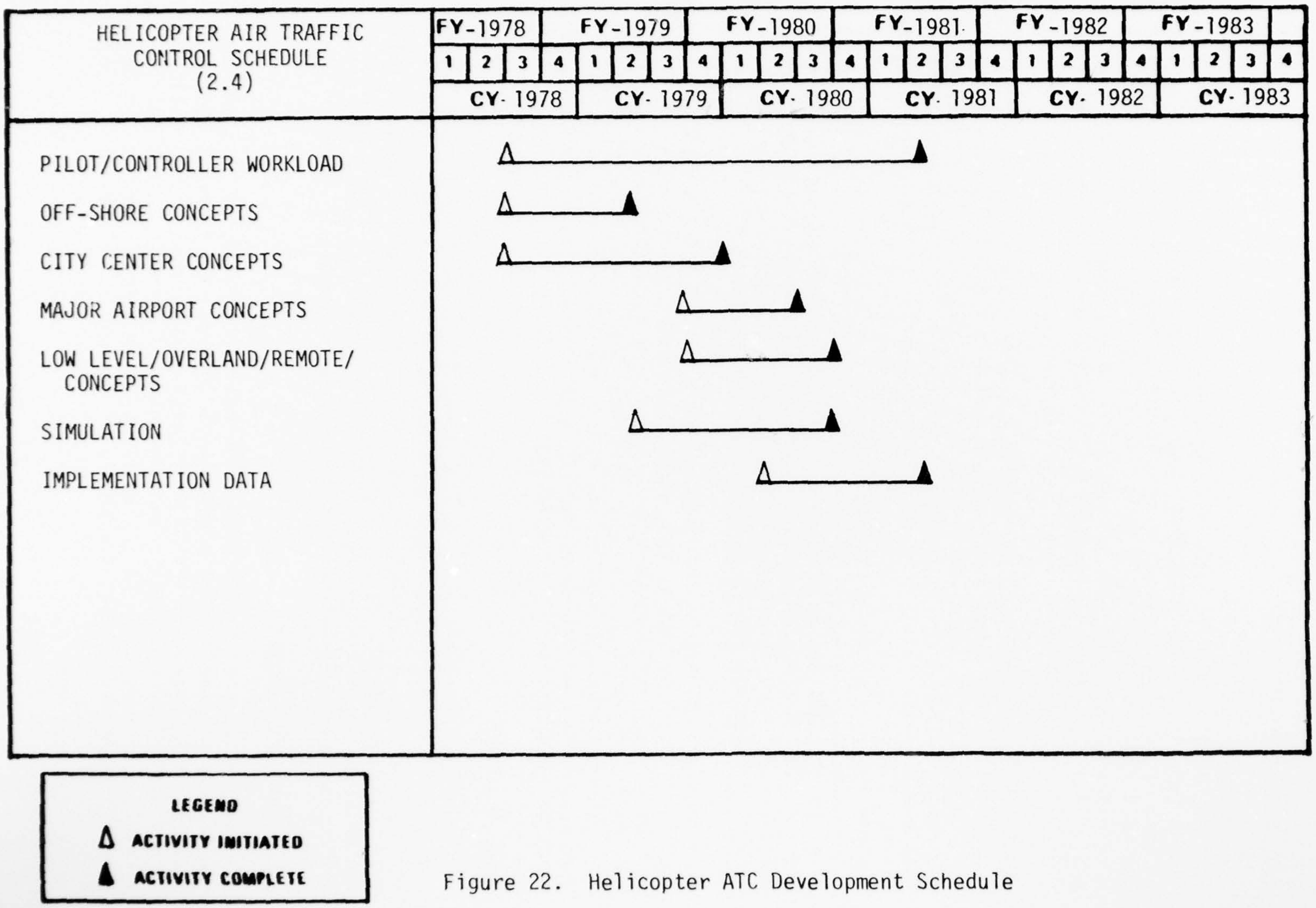


Figure 22. Helicopter ATC Development Schedule

2.5 Weather Environment

The introduction of large numbers of VFR and IFR helicopter operations into portions of the NAS, where high-density congested traffic problems are already in evidence and where significant adverse weather conditions frequently prevail, portends a new situation demanding careful attention. The weather environment will have a most significant impact on the successful integration and implementation of all facets of these new anticipated helicopter operations in the Northeast Corridor and the off-shore drilling areas of the Atlantic Ocean.

The FAA has the responsibility for determining the new or additional aviation weather requirements needed for implementing safe and extensive IFR and VFR helicopter operations within the NAS. The need for new weather equipment and innovative procedures, catering to the special needs of this new activity, will be of prime importance if the helicopter pilots are to receive timely, accurate and comprehensive weather information, forecasts and briefings in a usable format.

Also, the FAA has the added responsibility of conveying any new equipment requests and staffing requirements to the National Weather Service (NWS) and advising them accordingly so that they can include them in their plans and budgetary processes for prompt implementation.

The programs outlined in this section complement the FAA Aviation Weather System Preliminary Program Plan which describes a major effort to improve the existing aviation weather system. This plan is directed to integrating data acquisition, data processing, and communications performed in support of aviation into an improved, consolidated, cost effective, weather system that will meet both the near-term (- 1980) and long-term (-1990) requirements of all aviation.

2.5.1 Objective

The objective of the FAA weather environment effort (as described herein and in the Aviation Weather System Preliminary Program Plan) is to develop a system in cooperation with the National Weather Service (NWS) which will provide accurate, comprehensive weather information, forecasts and briefings on a timely, usable basis for pilots engaged in VFR and IFR helicopter operations within the National Airspace System (NAS).

2.5.2 Important Considerations

The civil helicopter fleet in the U.S. has been growing at a rapid rate and it is projected that by the mid-1980's there will be about 12,000 helicopters in operation with a very large number capable of IFR flight. Currently, the most extensive and concentrated domestic, civil helicopter operations are conducted in the Gulf/Off-Shore coastal area of the United States. Instrument Flight operations are conducted in this area under Part 91, SFAR 29 and 29-1. Although most operations are conducted on a VFR or "Special VFR" basis, some flights are conducted under IFR when required by the weather conditions.

The main reason for commenting on these operations here is to note the special conditions that may prevail for these IFR flights. Sketches of possible weather and flight profiles for activities between the main bases on land and the oil rigs in the Gulf are shown in Figures 8 and 9. On occasion, when the home base is "fogged-in", a returning flight must make a full ILS approach to the closest ILS-equipped airport (as depicted by the "Alternate Approach" shown in Figure 8). Therefore, the Gulf Coast helicopter instrument pilot is also occasionally forced into a high-density ATC/COMM/NAV environment complete with all the flight planning, holding enroute, flying in heavily controlled airspace and maneuvering with other airplane traffic in order to complete his CAT I approach. In effect, this indicates that they too may be faced with the identical situations that commonly prevail for airplanes at any high density airport. Also, this will be true probably to a greater degree for the Atlantic off-shore operations where the weather, relatively speaking, will be worse and the amount of controlled airspace and traffic will be greater.

On occasions when the ceiling is marginally low and the visibility is poor, many helicopter pilots will probably try to fly VFR underneath the ceiling and at slow speeds in the reduced visibility rather than fly on a fully implemented IFR flight plan. Therefore, as far as the weather environment is concerned, weather information will be required for helicopter operations for the full spectrum of activities associated with IFR, VFR and "Special VFR" flights. This spectrum may include weather information for the following cases or special circumstances:

- Weather primarily under 10,000 feet.
- Enroute weather at the surface and sea level.
- Enroute weather for cruising altitudes as low as 500 feet.
- Weather for "Special VFR" flight under low ceilings.
- Weather for "Special VFR" flight in poor visibility and obscurations.
- Flight to and from terminals or heliports that may not have an active weather observation service.
- Flight to and from platforms situated as far as 300 miles offshore.
- Full IFR-CAT II operations into high density terminals like Kennedy International Airport.
- Flight where significant icing conditions present serious problems.
- Flight where significant turbulence and thunderstorms present serious problems.

- Flight where significant or unknown wind conditions at the terminal may present inadvertent loss of control or "upset" problems.

- Flight where range and endurance may; (1) be marginal with respect to lengthy IFR holding periods, or (2) preclude diversion to distant "suitable" alternates if unexpected weather phenomena frequently occur.

Given the budgetary constraints normally imposed on all new activities, certain compromises will need to be made on new equipment purchases and staffing requests. This will be especially true regarding the addition of NWS personnel for the many new projected helicopter terminals. Since there are already many airport terminals with approved approach procedures where weather observation service is not readily available, it is anticipated that the same situation will prevail for many of the new heliport terminals and off-shore landing pads. Safe helicopter operations can be severely hampered by lack of accurate, comprehensive weather information and forecasts. This is especially true when obscurations, low visibility and unknown wind conditions exist and the pilot is required to make an approach to landing with no precise local weather information.

2.5.3 Critical Issues

- Establish the required coordination with the National Weather Service to develop and implement those plans and requirements necessary to provide existing and future helicopter operators with the necessary improved weather information, forecasts and briefing commensurate with their most urgent special weather needs.

- Icing climatology below 10,000 feet is not presently available. This climatology is required to support the development of helicopter icing criteria for certification and for use in operational planning.

- Develop improved icing forecasts and on-board ice detectors to insure safe operations. An alternate system would be to develop inlet and rotor blade deicing systems for a true all-weather capability. An assessment of benefits and costs of candidate solutions is necessary to support decisions on the optimum approach for effectively enhancing flight safety.

2.5.4 Major Tasks

- Task A - National Weather Service Liaison. Initiate coordination and information exchange with the National Weather Service for the timely and orderly provision of those special weather services required for the conduct of the projected wide spectrum helicopter operations within the NAS.

- Task B - Forecasts and Climatologies. Provide improved forecasts and climatologies including:

  - Icing, Visibility, Turbulence Forecasts. Develop improved reliable short range (0 to 4 hours) forecasts of icing conditions. These forecasts will include liquid water content (not presently forecasted), temperature, droplet size distribution (not presently forecasted), and cloud layers. These parameters are of direct use to the pilot in determining the effects of icing conditions on his aircraft. Until economical rotor blade deicing systems are developed, safe operations will depend on a reliable icing forecast. Improved forecasts of visibility, ceiling, and turbulence will be developed for IFR flights to specific heliports located on offshore platforms and in cities.

  - Icing Climatology. Provide enroute climatology of icing conditions to include liquid water content and temperatures useful for operational planning of helicopter flights. It will cover offshore areas and altitudes below 10,000 feet. These climatologies are non-existent at this time and will be useful in in establishing safe route structures.

  - Heliport Climatology. Provide climatologies of winds, visibility, and ceiling for heliport locations for planning heliports and determining operational limitations. Climatologies are available for air transport airports but not for heliports.

  - Wind Shear Effects. Conduct a simulation study of helicopter landings and takeoffs under a variety of wind shear models to determine the effects of wind shear on helicopter operations. Safe operational procedures under shear conditions will be developed.

- Task C - Meteorological Equipment. Provide meteorological observations.

  - Observation Systems Unique to Heliports. Adapt and test recently developed automated aviation weather systems for the unique size and location of heliports to assure representative weather observations. The unique features of heliports that require evaluation in adapting an observation system include small size, moving platforms, and ocean environments. The development of AV-AWOS (Automatic Aviation Weather Observation System) and ALWOS (Automatic Low-Cost Weather Observation System) for airports will be adapted to heliports and off-shore platforms. AV-ALWOS makes all the required observations for a CAT II airport; ALWOS will be installed at facilities having an instrument approach but no weather reporting system.

Ceiling (LIDAR) and visibility systems under development by the Navy and Air Force will be adapted to the high angle landing approaches of helicopters for CAT II operations. The data buoy system will be utilized to provide meteorological observations significant to off-shore helicopter operations.

- Airborne Weather Observation System. Adapt icing measurement systems for use on helicopters to provide helicopter pilots with timely icing information. Similarly, adapt and evaluate other weather observation equipment that could provide additional data such as temperature, winds, and other significant atmospheric parameters. Provide for transmission and display of icing information to the helicopter pilot as well as automatic transmission (AUTOMATIC-PIREPS) of this icing information and the other observed weather (together with aircraft location data) to dispatchers, forecasters and other pilots. This information may be utilized for safe flight-planning and for improving short range (zero to two hours) forecasts.

• Task D - Icing Criteria Support Data

Provide information on icing environment for developing icing criteria for certification of helicopters. Transport category standards for icing are in many instances inappropriate to helicopter aircraft. It is necessary to obtain environmental data; e.g., liquid water content, temperature, and drop size distribution below 10,000 feet (not presently available) to establish a reliable base for developing helicopter icing criteria for use in certification of helicopters. The frequency of occurrences of mixtures of freezing rain and snow, which cause severe icing as well as flameouts, is also required. It is necessary to establish more accurate relationships between the foregoing parameters with cloud types in order to improve forecasts of icing conditions. Coordination will be effected with NASA, the Army, and NOAA, to operate an instrumented aircraft to obtain the necessary data.

2.5.5 Program Management, Coordination, and Interagency Participation

Overall Management of the Helicopter Operations Development Plan is under the Approach and Landings Division, ARD-700 (and ARD-706). Specific weather requirements, tasks, and direction will be under the control of the Aviation Weather Branch, ARD-450. The program schedule is presented in Figure 23.

Other coordination and interagency participation will include:

• Direct coordination with the National Weather Service (NWS); requesting those special services deemed appropriate for the

helicopter operations envisioned. This action will include communications with the Secretary of Commerce (in accordance with Section 310 of the Federal Aviation Act of 1958) informing him of the projected requirements and/or additional weather services needed for these operations. These efforts are expected to include comprehensive low-altitude weather observations, short range forecasting and weather briefing services for helicopter pilots. Some specific items of interest would be visibility in obscurations, wind conditions, turbulence, ceilings and any other special weather conditions that could hamper VFR and IFR helicopter operations. Both enroute and terminal problems, associated with operating at the lower altitudes on-shore, between cities, at heliports and airports as well as elevated landing areas situated on buildings or on off-shore drilling platforms, will be addressed.

- The climatic studies and improved forecast developments will be attained with the participation of the National Oceanic and Atmospheric Administration (NOAA) organizations which have expertise in these areas; i.e., the National Climatic Center and the NWS. The simulators at NASA-Ames Research Center will be utilized for the wind shear simulation.

- A cooperative effort will be estalished with the Army, Navy, Air Force, and NOAA to aid in developing helicopter icing criteria for use in the IFR certification of helicopters. The Air Force WC-130 will be utilized to obtain environmental data. These agencies will also cooperate in analyzing the data acquired.

- The NWS, National Data Buoy Office, and the Air Force will participate in the development and testing of the meteorological equipment.

2.5.6 Funding Requirements

Weather Environment Funding Requirements (FY $000):

	1980	1981	1982	1983
Total	190	655	555	300

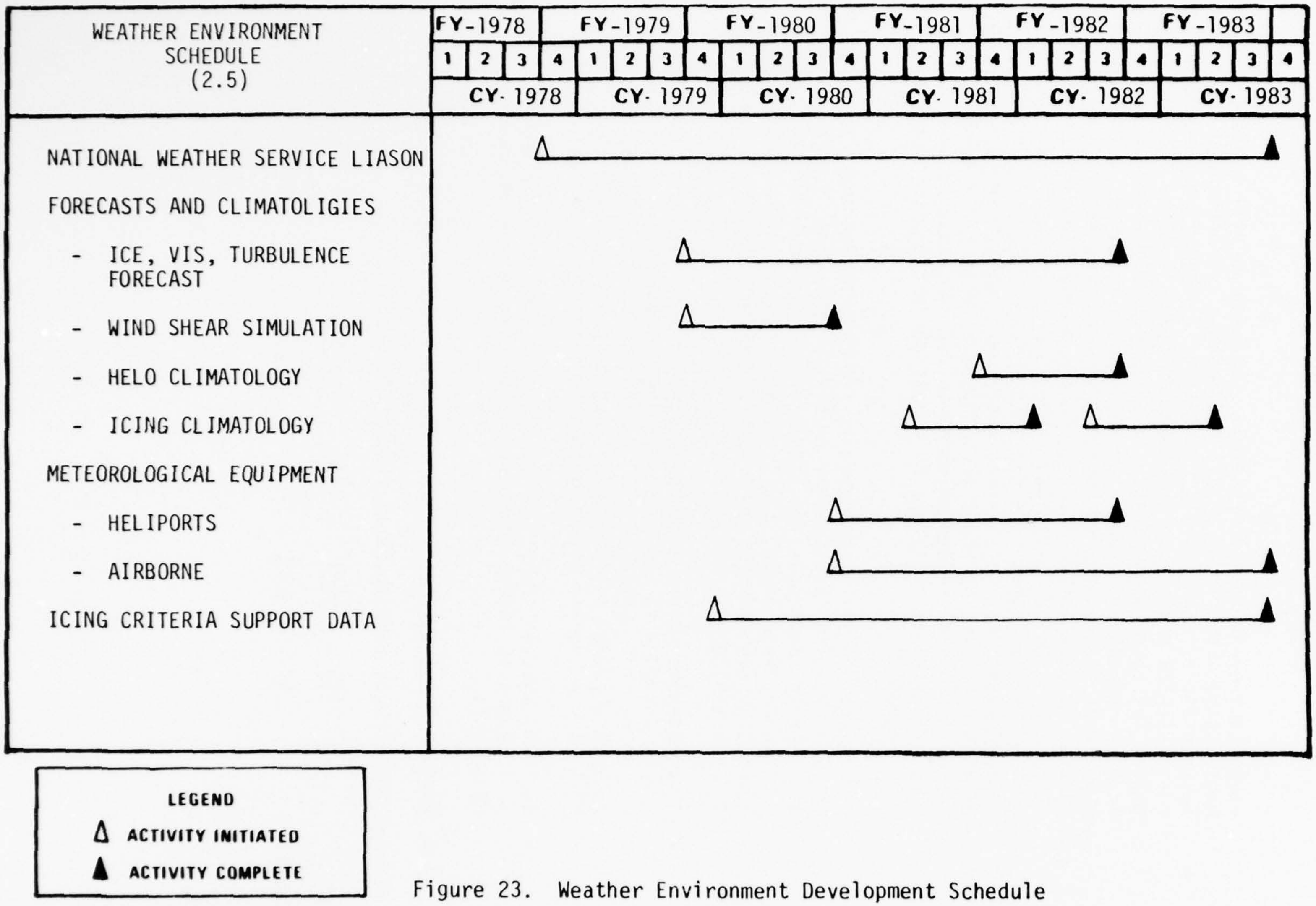


Figure 23. Weather Environment Development Schedule

2.6 All-Weather Heliport

The heliport represents a landing and takeoff area uniquely designed for helicopter operations. To land there, a helicopter pilot must obtain visual contact with the pad and come to a stationary hover over it. Obviously, the earlier he can transition to visual cues, the less severe will be the requirements for other guidance, and the more useful the facility will be. Thus, the heliport should be the focal point for many of the terminal area study efforts.

The current Heliport Design Guide gives general guidance for lighting on an off-shore helicopter facility, but discussions with several helicopter operators indicate a need for more definitive information. This program will involve a thorough review of flight test and studies already completed, and will address the current needs of off-shore helicopter operators.

2.6.1 Objective

The program's objective is to determine the most suitable lighting system for heliports with emphasis on off-shore oil rig requirements.

2.6.2 Major Tasks

The program will include nine tasks designed to review all available lighting and marking devices as potential candidates for use on platform operations in all meteorological conditions including obscurations, snow or rain conditions in congested, off-shore and remote environments with positive IFR control to touchdown. Much of this will consist of evaluating the results of the tests already completed, but several of the most desirable devices will actually be flight tested. (See Figure 24).

- Task A - Perimeter Lights. Review use of perimeter lights and floodlighting to determine degree of increasing depth perception with floodlights over that provided by perimeter lighting (particularly transition from instruments to contact).

- Task B - Lighted Wind Indicator. Review need for lighted wind indicator for earlier detection of crosswind correction requirements (particularly when transitioning from instruments to contact).

- Task C - Rotating Beacon. Review need for heliport rotating beacon during transition from instruments to contact, day and night, 45-60 flashes per minute, alternating white, green, and amber.

- Task D - Visual Approach Slope Indicator (VASI). Determine need for VASI, particularly during transition from instruments to contact.

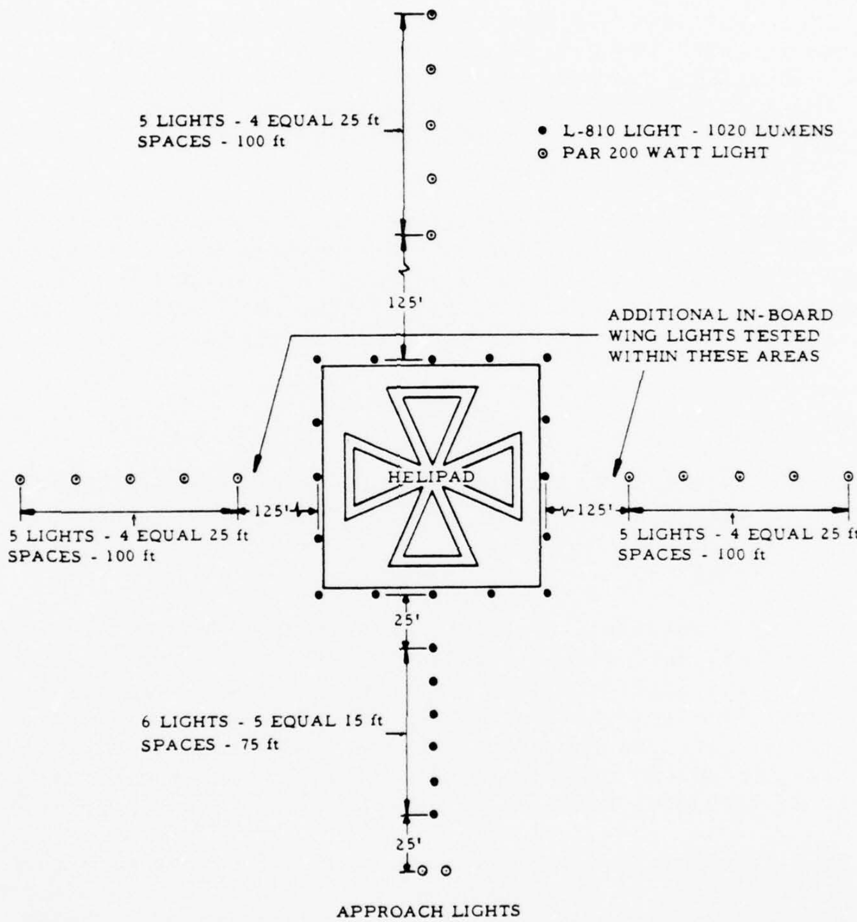


Figure 24. Heliport Lighting Design Evaluated During Past Flight Programs

- Task E - Strobes. Determine the extent to which approach lights are required with weather minima less than 200 feet Decision Height and 1200 feet RVR.

- Task F - Flashing Landing Directional Lights. Determine requirements for landing directional lights and the need for flashing in sequences.

- Task G - Line-Up Lights. Coordination with DOD to determine value of stabilized glideslope indicators (GSI) and sequence-flashed line-up lights.

- Task H - Other Airports. Evaluate other airport facilities as may be required to meet objectives.

- Task I - Design Criteria. Develop heliport design criteria to meet objectives and goals above.

2.6.3 Interagency Participation

This program involves the operational evaluation of various lighting concepts and their impact on the terminal helicopter IFR task. Installation of these lighting concepts will be requested at DOD, NASA, NAFEC, and perhaps DOT facilities for the collection of data and evaluation of the systems where necessary.

2.6.4 Program Management/Schedule

Program Management will be in accordance with Section 4. Program Schedule is set forth in Figure 25.

2.6.5 Funding Requirements

All-weather Heliport Funding Requirements (FY $000):

	1980	1981	1982
TOTAL	100	100	100

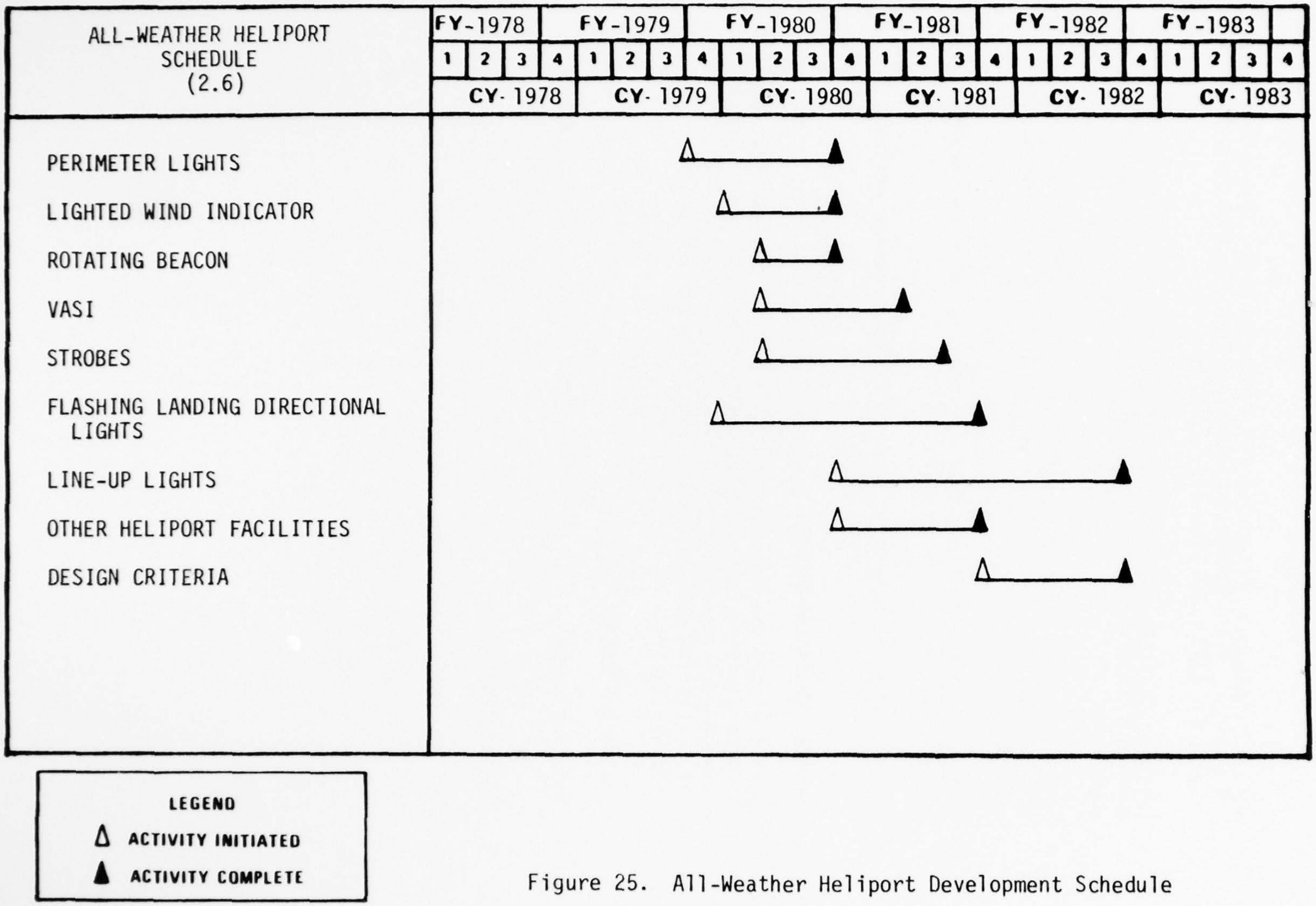


Figure 25. All-Weather Heliport Development Schedule

2.7 IFR Helicopter Certification Standards Program

At present no definitive standard exists for the certification of helicopters for operation in the IMC environment. Current certification is based on a document which has come to be known as the "Interim Airworthiness Criteria for Helicopter Instrument Flight". This document was developed around 1960, and permits helicopters to be certified for IFR operations by allowing manufacturers to demonstrate compliance with certain FAA requirements for helicopters or by demonstrating "equivalent safety".

The current Interim Standard essentially has not been updated since the early 60's and has been the subject of criticism by the industry as not representing the minimum criteria and, based on current technology, not realistic. Improvements in basic helicopter stability characteristics and related stability augmentation concepts have afforded an increased capability for helicopters to expand into the IMC environment. Control systems and display technology have advanced to the point that application of the "Interim Standard" in its current format is difficult and there is no explicit provision that provides credit for these systems when warranted.

2.7.. Objectives

The objective of this portion of the Helicopter Operations Development Plan is to develop aircraft certification standards and compliance means for IFR operations of helicopters. All facets of IMC operation and certification will be explored to fully incorporate current technology and provide for those characteristics unique to helicopters.

2.7.2 Major Tasks

- Task A - Update Interim Standards. Review existing standards relative to current technology and establish validity on the basis of that technology, define deficiencies, and recommend research designed to resolve deficiencies.

- Task B - Workload Stratification. Stratify workload requirements in terms of pilot monitorship and control of the aircraft and other systems which comprise the total workload requirement. This program will involve definition of levels of control and systems involvement and will address all parameters impacting workload spanning from open loop management to full pilot involvement and saturation.

- Task C - Man/Machine Performance. Define expected man/machine performance limitations in terms of performance parameters and as a function of task requirements. This definition will provide a common basis from which to assess workload requirements.

- Task D - Certification Integration Compliance Means. Devise a methodology for interrelating and integrating pilot workload,

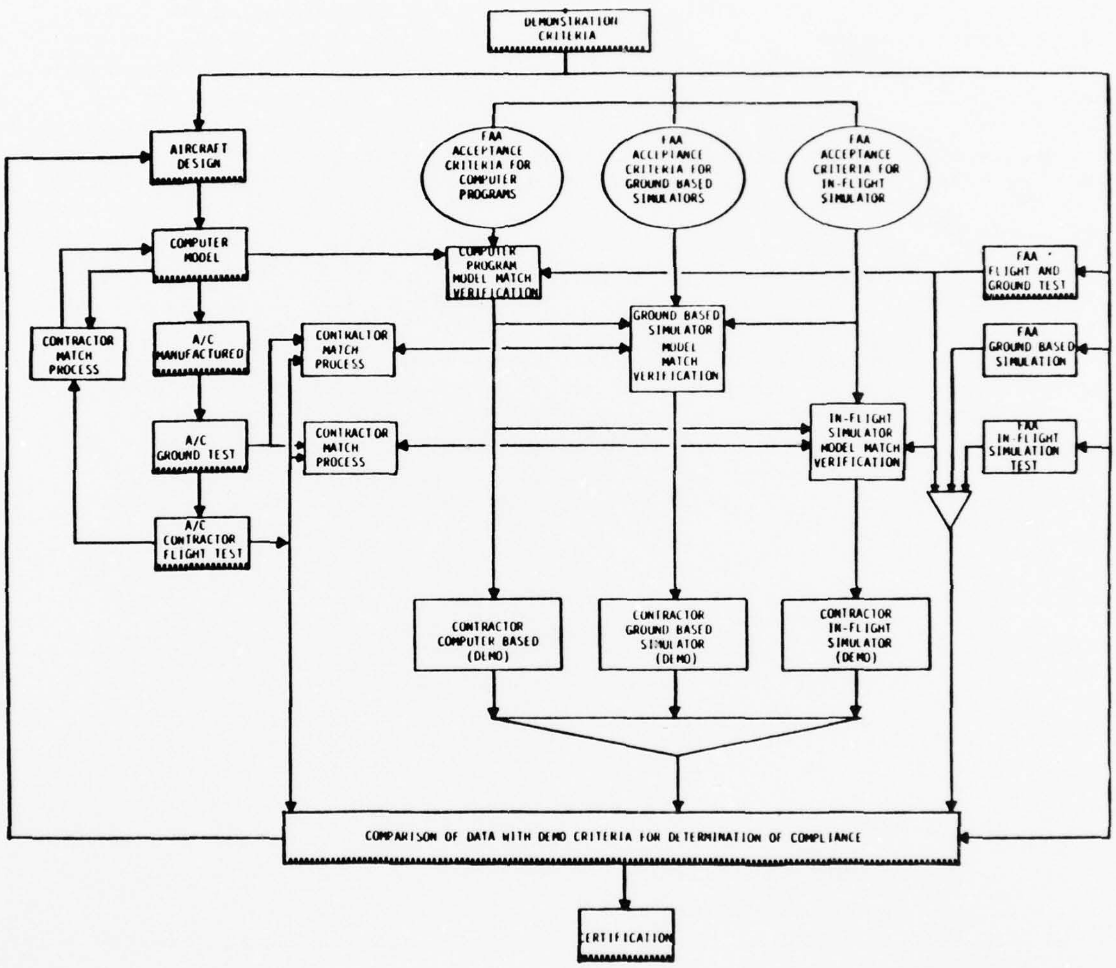


Figure 26. Candidate Improved Helicopter Certification Process

man/machine performance, and aircraft engineering characteristics in the certification procedures. Define compliance levels in terms of the variables affecting workload and lay the framework for the establishment of a system of credits as they pertain to these variables.

- Task E - Displays/Control System Credits. Define the interrelationship of displays and control system concepts as they impact on pilot workload and performance and explicitly define how this interrelationship could be integrated into a system of credits for a given proposed configuration. Define crew requirements in terms of configuration.

- Task F - New Certification Standards/Procedures. Validate through flight test the evolved methodology and procedures using the workload and credit tools developed.

- Task G - Simulation. Substantiate the validity of simulation as a certification tool. Define the fidelity requirements and verify them through the correlation of actual data with the simulation data. Specific answers to such questions as; what cues are needed, how many, and what degrees of simulation fidelity are required, will aid greatly in the design of a valid simulation. Any adverse physiological effects by type and magnitude should be addressed. The results of the program envisioned would provide the operating agencies with an economical and safe tool for their use.

One candidate plan for an improved certification process is shown in Figure 26. The interplay of flight and ground testing and simulation (both in-flight and ground-based) is shown to the right side of the Flow Chart (Figure 26).

2.7.3 Interagency Participation

In developing new certification standards and compliance means for IFR certification testing, it is intended that maximum use of the simulation facilities at NASA-Ames and the National Aeronautical Establishment in Canada be brought to bear in the definition and verification of compliance methodology, workload stratification, and definition of the interrelationships between flight displays, control system configuration, and crew complement. Final validation will be accomplished in the test vehicle defined in this plan.

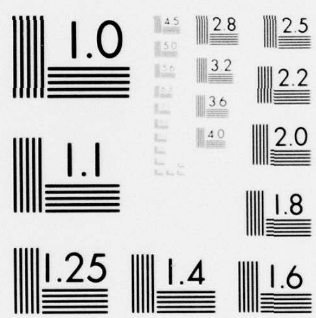
2.7.4 Program Management/Estimated Schedule

Program scheduling for the IFR Helicopter Certification Program is outlined in Figure 27. Program Management will be as set forth in Section 4.

AD-A061 921 FEDERAL AVIATION ADMINISTRATION WASHINGTON D C SYSTE--ETC F/G 1/2
HELICOPTER OPERATIONS DEVELOPMENT PLAN.(U)
SEP 78
UNCLASSIFIED FAA-RD-78-101 NL

2 OF 2
AD
A061921

END
DATE
FILMED
2 79
DDC


1.0
1.1
1.25
1.4
1.6
1.8
2.0
2.2
2.5
2.8
3.2
3.6
4.0
4.5
5.0

2.7.5 Funding Requirements

Helicopter IFR Certification Program Funding Requirements (FY $000):

	1978	1979	1980	1981	1982
TOTAL	50	225	700	650	350

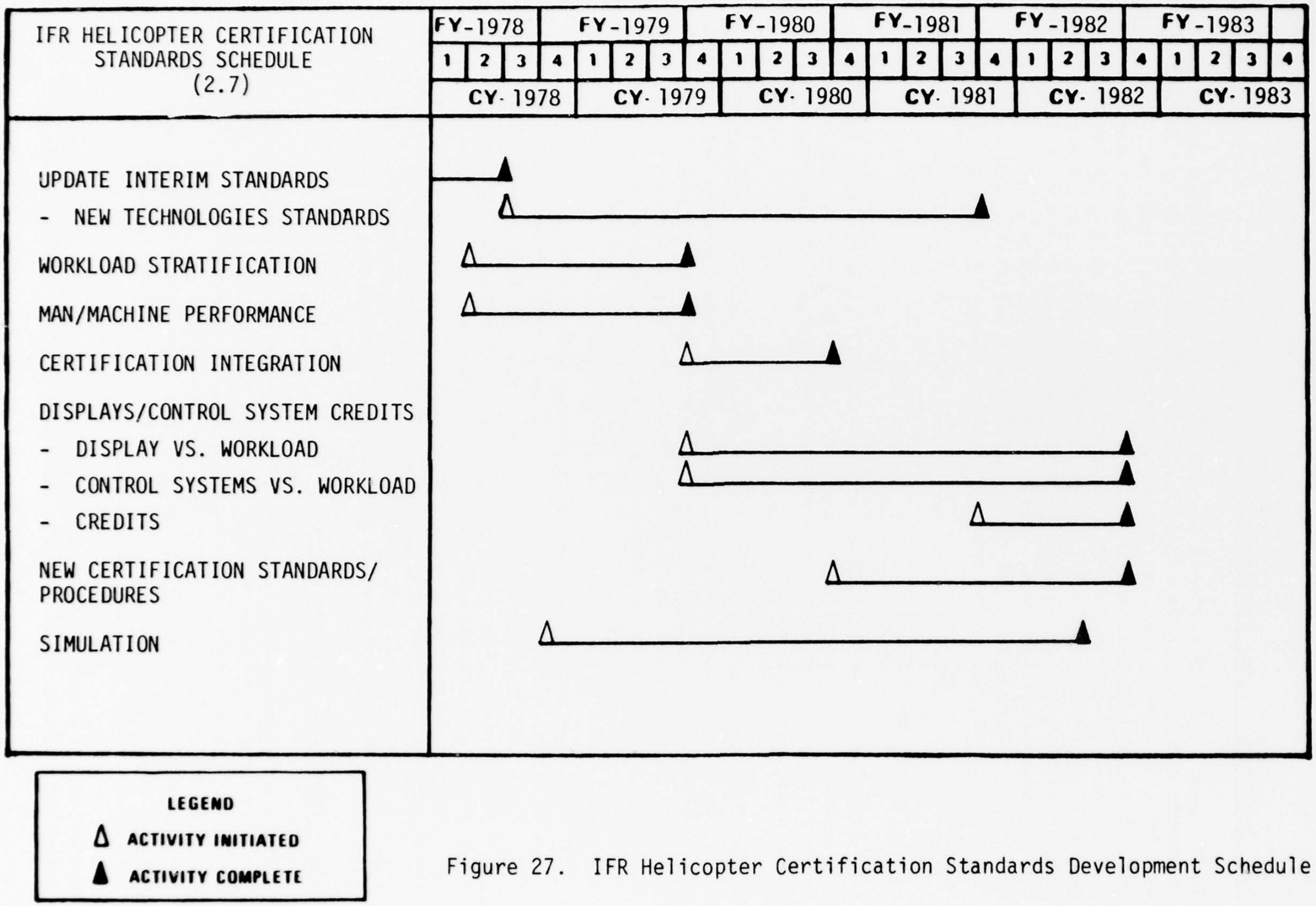


Figure 27. IFR Helicopter Certification Standards Development Schedule

2.8 Helicopter Icing Standards

In the past, primary emphasis on establishing icing criteria and standards has been concentrated on all-weather operations by fixed-wing aircraft. With more IFR certified helicopters coming into use, the impetus to conduct helicopter flights in known icing conditions is increasing. For the most part, current, civil IFR certified helicopters (and military) have limitations imposed on the conduct of flight in known icing conditions if the aircraft is not equipped with approved ice protection apparatus. However, several civil (and military) helicopters have been cleared for flight in certain icing conditions provided that the appropriate, effective icing protection equipment is installed and operable.

2.8.1 Objective

The objective of the Helicopter Icing Standards Program is to initiate development of the pertinent regulatory and advisory documents pertaining to certification and operation criteria associated with helicopter icing and ice protection systems.

- The short term objective is to issue an interim standard on icing as soon as practicable, in order to provide guidance for test and evaluation, establish effectiveness parameters, detail icing definitions specifically for helicopter use and determine reliability criteria for the various existing and projected helicopter ice protection systems.

- The long term objective is to review and correlate existing helicopter icing information with new, additional data obtained by implementation of various FAA research and development tasks pertinent to the helicopter icing problem and protection systems. These efforts will include updating of the standard and the technology data base, evaluation of icing factors such as ice shapes, surface contours, airspeed, etc., use of measuring and detection instrumentation, and effects of cloud icing paramaters such as outside air temperature and liquid water content.

2.8.2 Important Considerations

Previous experience with helicopter ice protection systems has revealed that many of the systems studied thus far have been very complex, expensive, heavy, unreliable and, in many cases, of questionable effectiveness. Also, it is important to realize that there are indications of significant differences in the manner of ice formation or the mechanism of accretion between airfoils and surfaces on fixed-wing aircraft as opposed to those on rotating wing aircraft.

Discussions of airframe icing and definitions of icing terms and ice accumulation factors detailing the intensities of accretion (e.g. as

discussed in the Airman's Information Manual) need to be updated to include helicopter operations and should reflect the different problems and effects associated with helicopter operations in icing environments.

2.8.3 Critical Issues

The critical issues for the Icing Standards Program as applied specifically to helicopter operations conducted in icing environments are:

- Prompt determination of those parameters, functions and definitions describing the basic certification requirements for reliable and effective helicopter icing protection systems.

- Issuance of an Interim Standard on icing (as soon as practicable) that provides guidance for test, evaluation and reliability criteria for helicopter ice protection system certification.

- Determination of the adequacy of existing icing test facilities and/or the need for additional facilities.

2.8.4 Major Tasks

Implement research and development efforts that will provide information and data necessary to update standards and advisory documents pertaining to the certification and operation of helicopters exposed to the icing environment. Include efforts that will establish standards for operating altitudes (10,000 feet and less) consistent with projected IMC routes and ATC procedures being developed in other parts of the over-all Helicopter Operations Development Plan.

The major tasks will include:

- Task A - Icing Standards and Technology Update. Review current FAA documents and certification practices and determine the degree of transferability and applicability of established precedent to the helicopter icing problem. Review current technology with emphasis on helicopter programs and define systems where ice protection technology is in hand. Define systems requirements where the technology is not in hand and where additional requirements will be necessary. List critical components in order of their importance and define systems requirements for increasing severity of exposure to ice.

- Task B - Interim Standard. Develop interim standard for icing certification from data obtained in Task A based on existing helicopter operations into icing environments. Consider as a basis both military and civil operations, as appropriate, and include as a minimum, the effects of size of particular aircraft and power margins available.

- Task C - Ice Shapes. Define minimum criteria in performance and handling qualities for unprotected helicopters exposed to ice. Define representative shapes for rotor blades and other systems for the assessment of performance and handling qualities degradation. Include consideration of asymmetric shedding and its impact on both aircraft and the surrounding area. Define the degree and nature of acceptable ice shedding, if any, and define its impact on aircraft flight characteristics.

- Task D - Instrumentation. Evaluate the state-of-the-art with respect to both environmental definition and ice detection and accretion instrumentation. Define instrumentation characteristics and determine if an optimum configuration could be designed to document both the environment and ice accretion characteristics as they pertain to certification testing. Include both experimental and standard instrumentation and systems. Define an optimum system.

- Task E - Icing Certification Tools. Survey current test facilities, analytical techniques, and other procedures and facilities applied to the definition and resolution of ice and icing problems. Define current deficiencies and recommend projected requirements.

- Task F - Ice Accretion. Define the mechanism, character, and rates of accretion of all forms of natural icing as a function of environmental conditions. Identify the primary and secondary hazards associated with each icing form and suggest ways to mitigate or eliminate these hazards.

- Task G - New Criteria and Procedures. Establish new criteria and test procedures based on previous work and current and projected certification tools. Identify the degree to which simulation could be useful and define an integrated and cost effective approach to icing certification.

2.8.5 Program Approach

The initial emphasis of the Helicopter Icing Standards Program will be directed toward that effort that will permit, as soon as it is practicable, the issuance of interim helicopter icing criteria for certification. Existing data, regulatory and advisory material in hand, as well as new technology information, will be reviewed and integrated in order to provide ice protection design and evaluation criteria. In addition, near-term efforts will identify those areas where technology is lagging and research and development tasks need to be implemented.

Prompt appraisals will be made of the existing test facilities so that if new facilities are required, the initial planning and budgetary

processes may be made in a timely fashion to account for the long lead times and the capital budgeting/appropriation cycles needed for acquiring and activating new facilities.

2.8.6 Program Management and Interagency Participation

The icing standards program related to helicopter operations as detailed in this plan will be managed by the Systems Research and Development Service (SRDS) as set forth in Section 4. Specific requirements, tasks and direction will be under control of the Airworthiness Branch, ARD-500. The program schedule is outlined in Figure 28.

Investigations into helicopter icing problems have been carried out and are continuing in other organizations and in foreign countries. Coordination will be effected with these other organizations, foreign and domestic, to take advantage of knowledge already gained by these sources and to use their resources, where practical, in carrying out new icing investigations.

Stong NASA and Army participation is required in basic research to define accretion characteristics and blade icing shapes and the performance degradation related thereto. This will involve joint effort and use of NASA wind tunnel facilities both at Ames and Lewis Research Centers and participation with the Army in their flight test program using the UH-1H icing test aircraft and the CH-47 spray aircraft. If current studies indicate an inadequacy in the icing facilities area, a major coordinated effort may be required in the development of a new facility for joint use in icing research and icing certification.

2.8.7 Funding Requirements

Helicopter Icing Standards Program Funding Requirements (FY $000):

	1978	1979	1980	1981	1982
TOTAL	330	225	600	800	1300

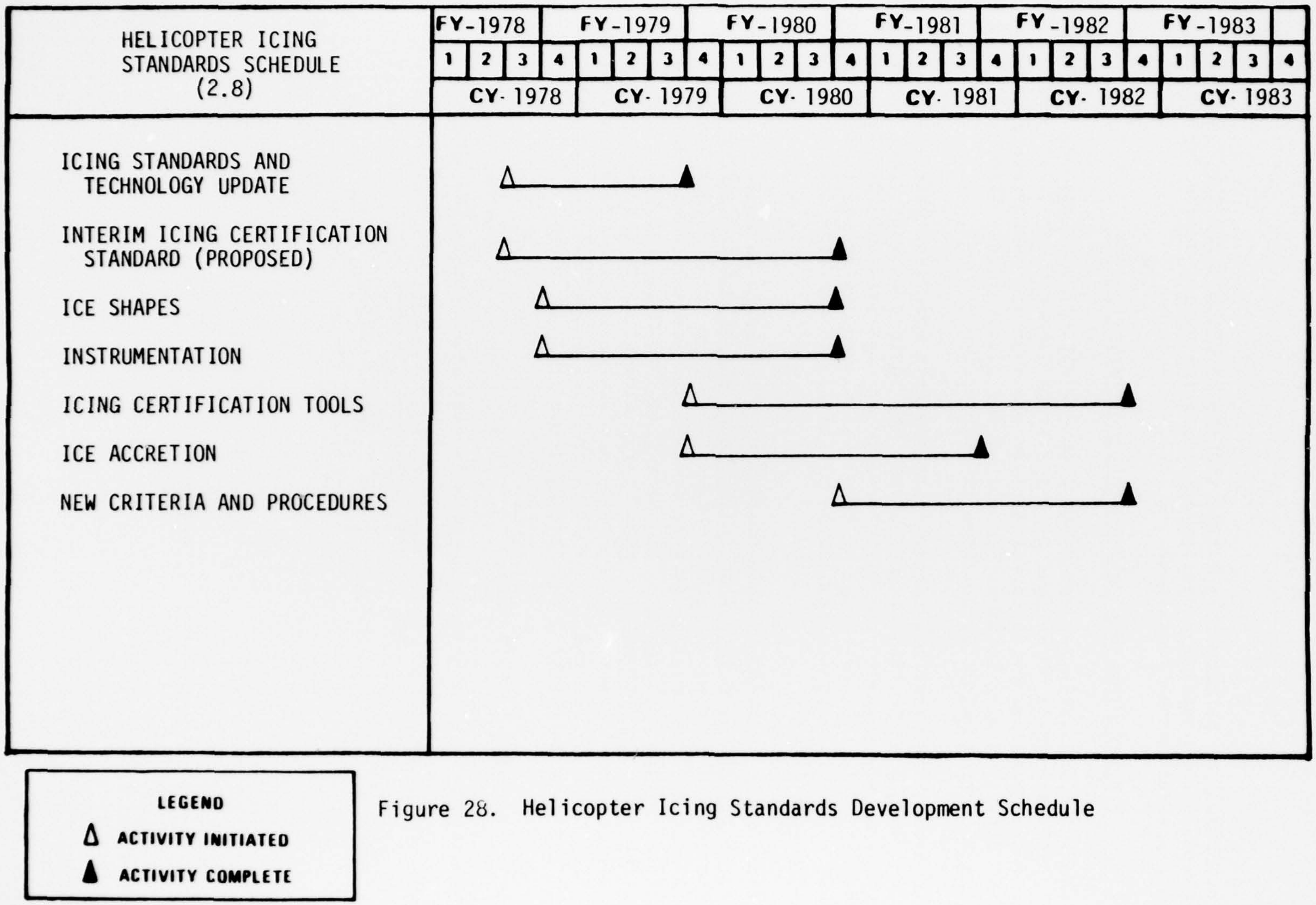


Figure 28. Helicopter Icing Standards Development Schedule

2.9 Helicopter Crashworthiness

No crashworthiness standards currently apply to the design of the basic airframe of the helicopter.

The current standards for certifying helicopters do not contain procedures and criteria which can be used to represent the actual dynamics of a crash impact situation. As such, the requirements provide a relatively unknown level of crashworthiness.

2.9.1 Objective

The objective of this effort is to provide certification standards and compliance means for improving the airframe, seat, and fuel tank crashworthiness of helicopters.

2.9.2 Major Tasks

The following seven tasks should allow for an orderly transfer of general aviation airplane technology and certain DOD technology to provide the basis for a reasonable level of crashworthiness.

- Task A - Procure Test Helicopters. Procure helicopters to be used in Program "KRASH" and full-scale crash testing.
- Task B - Modify Program "KRASH". Modify Program "KRASH" (developed for general aviation airframe response to crashes) to accommodate helicopter designs and apply to the analysis of three helicopter crash tests. Loads, accelerations, deformations, time of significant failures, etc., will be predicted.
- Task C - Modify Program "SOM-LA". Modify Program "SOM-LA" (developed by Dynamic Science and Penn State University to analyze the response of general aviation aircraft seats) to accommodate helicopter seats and to predict seat/occupant restraint in the tests conducted. Modifications considered include vertical energy absorption, load inputs at each leg, separate seat and occupant masses for analysis of heavy seats, etc.
- Task D - Develop Crash Resistant Tanks. Develop crash resistant tanks and valves based on Army helicopter (heavyweight) and FAA general aviation demonstrated (lightweight) bladder crash resistant fuel tanks and crash closing valves which are more appropriate for civil helicopters. These tanks and valves will be tested both during component and full-scale testing.
- Task E - Conduct Three Crash Tests. Conduct full-scale test of three helicopters at the National Aeronautics and Space Administration, Langley Research Center, test facility in the same

manner as those conducted for general aviation aircraft. Selection of the test parameters will provide information pertaining to the definition of the crash environment.

- Task F - Develop Crash Environments. Crash environments will be defined which represent the range of potentially survivable crashes including such factors as terrain, helicopter attitude, descent speed, angles of pitch, yaw and roll, etc.

- Task G - Propose Criteria. Propose certification standards to the Flight Standards Service (AFS).

2.9.3 Current Practice

For seats, occupants, restraints and mass items that could come loose and present a hazard, static load factors are individually applied in each direction to ensure retention under what are called emergency landing conditions.

Fuel lines are generally designed to preclude failure of fittings and attachments where lines pass through bulkheads, etc. The tanks themselves are not specifically designed to be crashworthy but for specified landing conditions, the structure around the tank must preclude fuel spillage. Other tank system requirements are intended to result in design of structures such as landing gears, so that when they fail they will not penetrate the fuel system.

2.9.4 Program SOM-LA

The SOM-LA program involves the development of a computer simulation of seat, occupant and restraint system response to crash impact conditions.

This effort was undertaken in response to the agency needs to improve occupant survivability and minimize injury in a crash.

Standards were general in nature and described the desired capabilities to represent the seat/occupant/restraint response to crash accelerations, utilized equipment and language generally available to the industry and automated as much of the program as possible to minimize the technical expertise needed for its application.

A draft users' manual has been prepared and is being modified as test data becomes available. The manual describes the use of the program, data preparation, possible problem areas and means to avoid or overcome them in the use of the program. Program listings, sample problems and results interpretation are included.

About eight test conditions of rigid seats with flexible legs and 30 real seat tests are to be used to establish the validity of the method. Early

test results indicate excellent representation of the occupant but that modification is necessary in the representation of the seat.

2.9.5 Program KRASH

The KRASH program involves a computer simulation of airplane structural response to crash impact conditions.

This program was initiated by the U.S. Army for the prediction of helicopter crashworthiness. The FAA has expanded its capability and added features to it, making it a tool for the general aviation industry to use. This effort was undertaken in response to agency needs for improving aircraft crashworthiness.

Standards were general in nature and described the desired capabilities to represent aircraft structure and impact conditions, to utilize computer equipment and language generally available to the industry and to automate as much of the program as possible to minimize technical expertise needed for its use.

A detailed three-volume users' manual has been prepared describing the program, data preparation, possible problem areas and means to avoid or overcome the.. in the use of the program. Program listings, two sample problems, and results interpretation are included.

Four full-scale crash tests of general aviation type aircraft were used to verify the capability of the program. The test results (loads, acclerations, deformations, failures, time, etc.) indicate good agreement with the predicted results.

2.9.6 Program Management/Estimated Schedule

Program Management will be as set forth in Section 4. The schedule for the Helicopter Crashworthiness program is outlined in Figure 29.

2.9.7 Funding Requirements

Helicopter Crashworthiness Funding Requirements (FY $000):

	1979	1980	1981	1982	1983
TOTAL	300	690	550	300	150

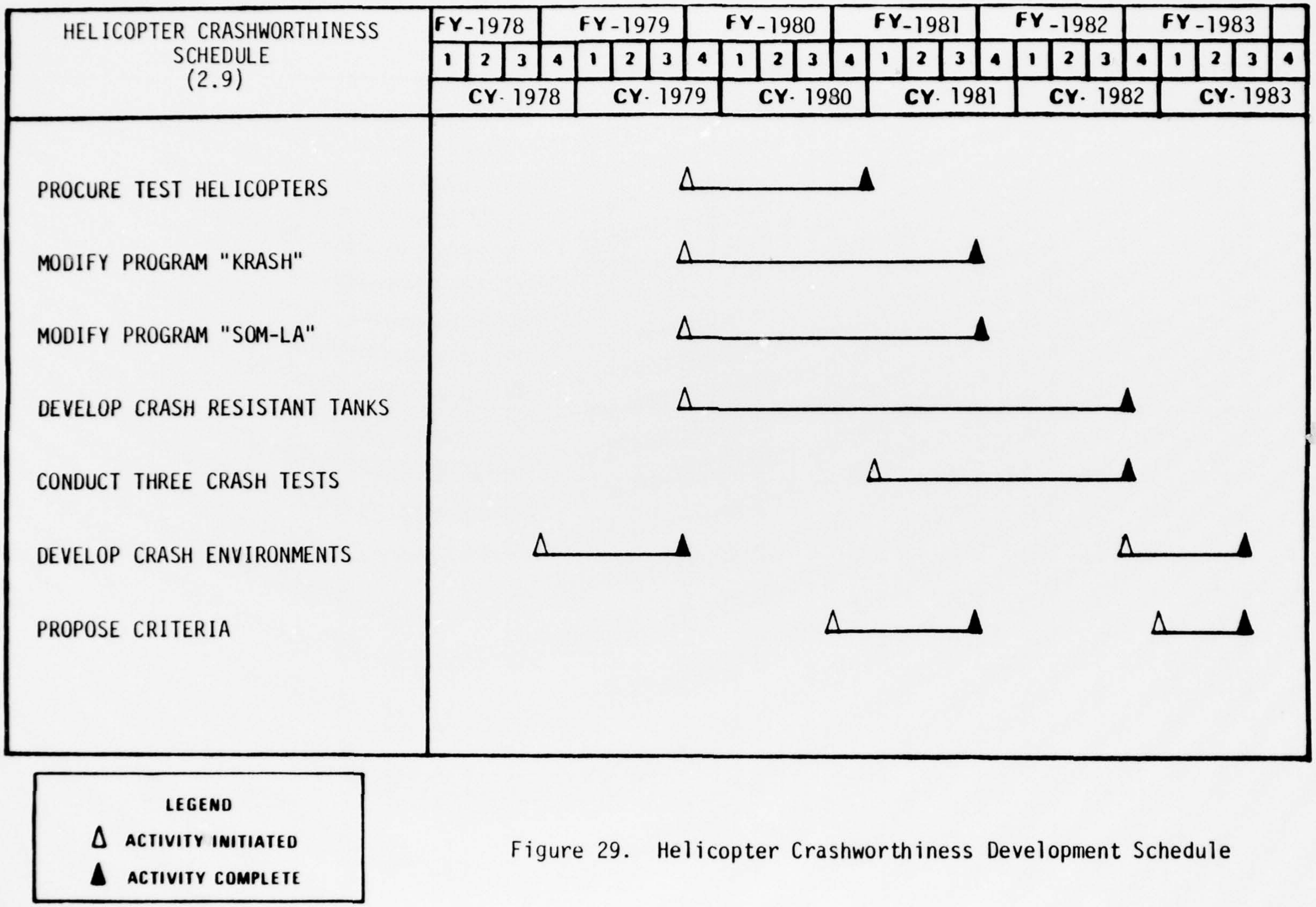


Figure 29. Helicopter Crashworthiness Development Schedule

2.10 Helicopter Noise Characterization

With approximately 7,000 domestic helicopters in operation, the areas and number of people impacted by helicopter noise have increased greatly. Continued increases in helicopter usage in regular passenger service may be stimulated by the fact that no new major airports are planned in the U.S. in the near future, but this growth may eventually be restricted by the community noise problem.

In addition to community noise, interior noise is a problem from the standpoint both of safety and of passenger acceptance. The high noise levels contribute to pilot fatigue and may reduce the accuracy of communications. Cabin noise and vibration have long been the chief complaint of passengers and have contributed to the slow growth in regularly scheduled helicopter passenger service.

Presently, no regulations exist for certification of helicopter noise, although the Federal Aviation Administration and International Civil Aviation Organization (ICAO) are developing standards concurrently. These standards are being based on data acquired by industry, FAA, National Aeronautics and Space Administration, and ICAO.

2.10.1 Objective

The general objective of the helicopter noise characterization effort is to continue to expand the helicopter noise data base in order to support future regulatory efforts and assess and minimize negative system characteristics due to exterior and interior noise.

2.10.2 Important Considerations

Helicopter noise standards are now being developed concurrently by FAA and ICAO to result in a common standard. The Office of Environmental Quality currently plans to release a Notice of Proposed Rule Making on helicopter noise certification in the near future, to be followed by the publication of a regulation sometime next year. Additional research and development (R&D) effort is not required to support this regulatory action, but work is needed to expand the data base for future regulatory support, anticipate any special noise problems of new technology designs, and to investigate methods of interior noise abatement.

One issue that can be raised is whether or not the FAA should be expanding the research effort in the area of prediction since a noise rule is already in preparation. There is a need for a general helicopter noise prediction model, more accurate than those currently available, which could be used to evaluate proposed noise abatement methods and the effects of design changes. Each of the major helicopter manufacturers

have some in-house prediction capability, but this is not readily available to the Government or to others, nor is it certain that any of these prediction methods could be applied as accurately to another manufacturer's product due to differences in design philosophy and approach. For a similar reason, economic studies of noise reduction methods are of limited value without a good, generally accepted prediction model. The successful application of noise reduction technology to one helicopter type does not mean that it can be applied to another which probably has been designed to very different requirements.

2.10.3 Technical Approach

2.10.3.1 Prediction Model

To aid in the assessment of changes in noise impact due to change in design, operation or certification requirements, a component based helicopter noise prediction model will be developed which can be used for parametric studies. This task will be coordinated with NASA to avoid unnecessary duplication and it will also support the FAA's Integrated Noise Model. A data base will be assembled, available component prediction methods will be reviewed, and a general prediction model for noise during takeoff, hover, cruise and approach will be prepared.

2.10.3.2 Noise Abatement Operations

Noise abatement approach and departure procedures will be investigated and recommended. Blade slap as a function of rotor speed, rate of descent and airspeed will be analyzed and procedures to reduce slap will be defined and demonstrated.

2.10.3.3 Interior Noise

Representative helicopter interior noise and vibration levels and duration will be determined. Psychoacoustic tests will be conductd to determine possible communications problems, temporary threshold shift and noise-vibration induced fatigue. Interior design noise and vibration criteria will be recommended.

2.10.3.4 Hardware Demonstration

Promising noise abatement modifications appliable to current helicopters will be analyzed and those with the greatest potential for economical and practical application will be selected for limited flight testing. The purpose of this effort is to determine noise reduction technology which could be used on both current and future helicopters. It is anticipated that this would be a joint industry-FAA venture.

2.10.4 Major Tasks

Enhance the near-term application of the proposed noise standards and, provide a technical base to help determine the need for and define future regulatory action.

2.10.4.1 Noise Prediction Model

Develop a component based helicopter noise prediction model capable of external and internal noise prediction which can be used for parametric studies.

- Task A - Prediction Model. Assemble a data base and available component prediction methods and prepare a general prediction model for noise during takeoff, hover, cruise and approach.

- Task B - Model Verification. Verify prediction model using test stand and flight data; modify where necessary.

2.10.4.2 Noise Abatement

Investigate and recommend noise abatement approach and departure procedures.

- Task A - Analytical Study. Perform an analysis of blade slap as a function of rotor speed, rate of descent, and airspeed and define proposed operational procedures.

- Task B - Flight Test. Demonstrate proposed procedures and record noise data.

- Task C - Analyze Results. Analyze test results and determine applicability of procedures to actual operations.

2.10.4.3 Noise Reduction Demonstration

Demonstrate noise reduction technology applicable to current or future helicopters.

- Task A - Selection of Approach. Identify promising noise abatement modifications applicable to current helicopters and select those with greatest potential for economical and practical application.

- Task B - Fabrication. Fabricate test item.

- Task C - Demonstration. Conduct limited flight tests to demonstrate installed noise reduction.

2.10.4.4 Interior Noise

Determine effect of interior noise on flight safety and passenger acceptance.

- Task A - Interior Noise Exposure. Investigate relationships between interior noise level, exposure duration and the impact of noise exposure, including annoyance, communications interference, temporary threshold shift, and fatigue.

- Task B - Psychoacoustic Tests. Design and conduct psychoacoustic tests to verify the relationships and define interior noise criteria.

2.10.5 Program Management/Estimated Schedule

The Schedule for the Helicopter Noise Characterization program is outlined in Figure 30. Program Management will be as set forth in Section 4.

2.10.6 Funding Requirements

Helicopter Noise Characterization Funding Requirements (FY $000):

	1979	1980	1981	1982	1983
TOTAL	300	300	300	300	300

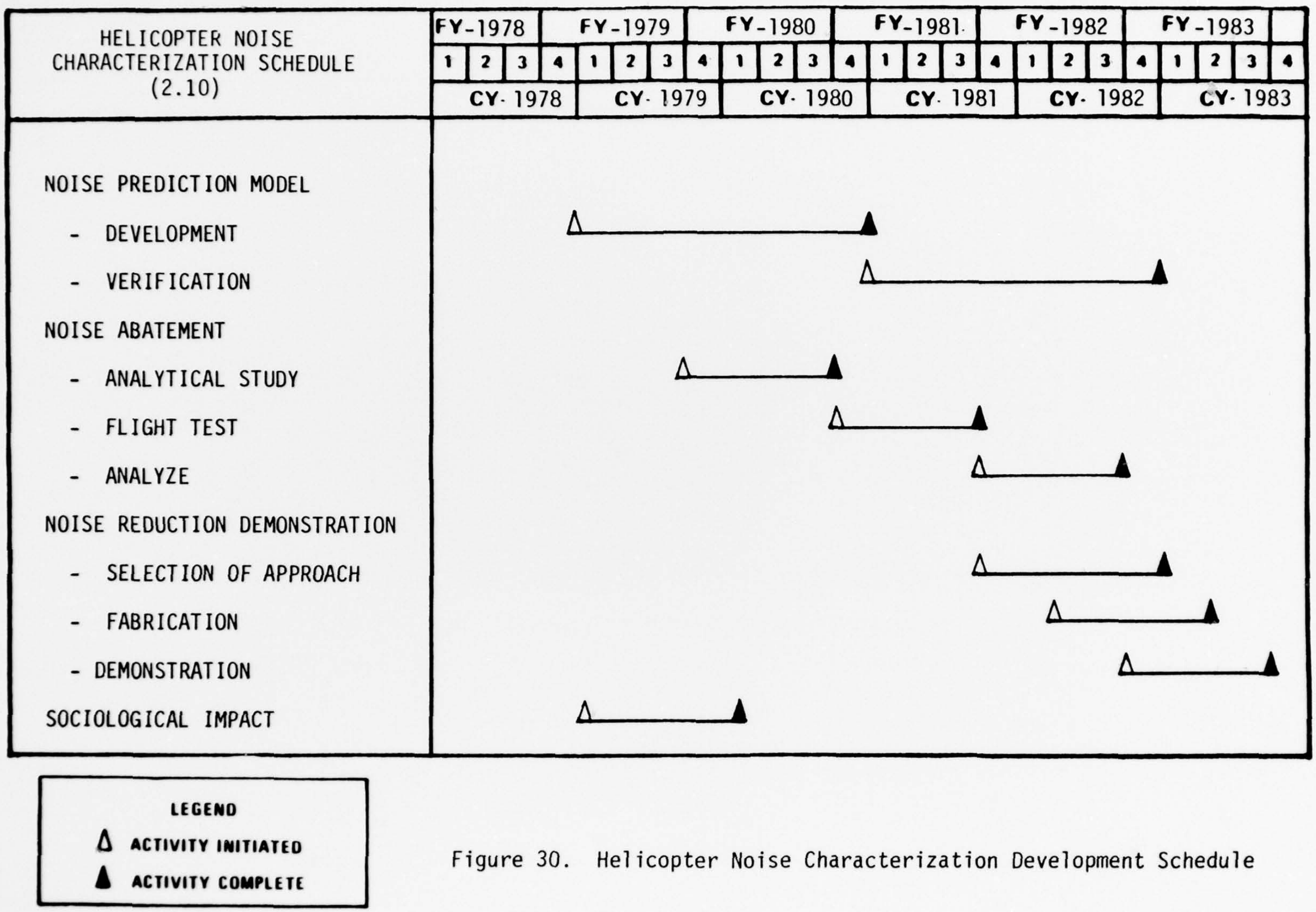


Figure 30. Helicopter Noise Characterization Development Schedule

3.0 Funding Requirements

Funds required to provide for the timely integration of the helicopter into the NAS system are identified in Table III. The funding breakdown presented in Table III is structured to illustrate that priority has been given to those efforts which hold promise of allowing implementation of short term, interim products or services.

SUB-SECTION	AREA	FY 78	FY 79	FY 80	FY 81	FY 82	FY 83	TOTAL
2.1 2.2	IFR OPERATIONS (+ NAVIGATION)	300	500	700	350	350	250	2,450
2.3	COMMUICATIONS		100	100	100	100		400
2.4	ATC DEVELOPMENT	100	200	300	100			700
2.5	WEATHER ENVIRONMENT			190	655	555	300	1,700
2.6	ALL-WEATHER HELIPORT			100	100	100		300
2.7	IFR CERTIFICATION	50	225	700	650	350		1,975
2.8	ICING STANDARDS	330	225	600	800	1,300		3,255
2.9	CRASHWORTHINESS		300	690	550	300	150	1,990
2.10	NOISE		300	300	300	300	300	1,500
	TOTAL	780	1,850	3,680	3,605	3,355	1,000	14,270

NOTE: Availability of estimated funds is subject to OST/OMB/Congressional actions. Funding estimates reflect planned program milestones subject to availability of funds. Current year estimates are consistent with the Helicopter Operations Development Fiscal Program.

TABLE III. SUMMARY OF FUNDING REQUIREMENTS ($000)

4.0 Program Management

4.1 General

The Helicopter Program Staff (ARD-706) was established within the Systems Research and Development Service on April 5, 1978 to provide focus for all helicopter research activity within the FAA. This office will be the principal element responsible for planning, managing implementation and coordinating all engineering and development activity pertaining to civil helicopter activities within the National Airspace System. The responsibilities of this office include: general management of the helicopter program implemented within the functional divisions of SRDS and other FAA research activities (NAFEC, Aeronautical Ctr, Regions, etc.); integration of requirements from other FAA offices and services into technical program objectives and technical/managerial coordination and monitorship of both unilateral and multilateral programs with other external agencies (NASA, DOD, NOAA, USCG, etc.) conducting research pertinent to fulfillment of the objectives of the Helicopter Operations Development Plan.

4.2 Functions

- Planning and programming all engineering and development activities (a) for improvement of helicopter operations in the National Airspace System, (b) for the development of new elements of the National Airspace System that may be required to support efficient helicopter operations, and (c) for those activities designed to foster and encourage improvements in supporting helicopter operations.

- Developing budgetary and fiscal programs required to implement the Helicopter Operations Development Plan.

- Defining and assigning projects, tasks, and priorities required to implement the Helicopter Operations Development Plan.

- Managing, directing and controlling the Plan to assure that schedules, tasks, projects, and programs in the Plan are efficiently executed.

- Coordinating with other government agencies and industry as necessary to achieve effective use of national resources in the development of improved supporting helicopter operations.

- Maintaining cognizance of the state of development of helicopter technology and the progress achieved in executing the Plan.

- Providing technical consultation and assistance to other offices and services within the administration and with other government agencies and aviation organizations.

4.3 Program Office Structure

The program office structure is given in Figure 3. It includes staff and administrative elements assigned directly to the Program Manager from each of the functional divisions. These representatives are responsible for technical program execution and final coordination with their respective operating services (through the Helicopter Operations Task Force) and NAFEC (for test and evaluation requirements and sub-program execution).

The Program Management Staff is responsive and responsible to the Program Manager on a full time basis to assist in the execution of his management responsibilities. Division representation is assigned on an as-required basis within its functional area of expertise to execute the program elements and be responsible to the Program Manager for the technical aspects of the Plan. Non-technical support (i.e., administrative, personnel etc.) will remain division responsibility.

Identification and definition of certification and operational requirements will be accomplished through representation and interaction with the Helicopter Operations Task Force. For those elements of the Plan assigned to NAFEC for execution, coordination will be accomplished through the NAFEC project manager by the SRDS Helicopter Program Manager with the assistance of his staff.

4.4 Program Coordination

Program coordination with all participants involved in the planning and execution of the Helicopter Operations Development Plan is the responsibility of the Helicopter Program Manager. This includes: identification of both technical and support requirements and personnel, resources and facilities allocation; initiation and coordination of interagency and international agreements; integration of related efforts of other agency programs and continued dialogue with all civil operating and industrial entities and their representatives to insure Plan relevance to current and projected needs.